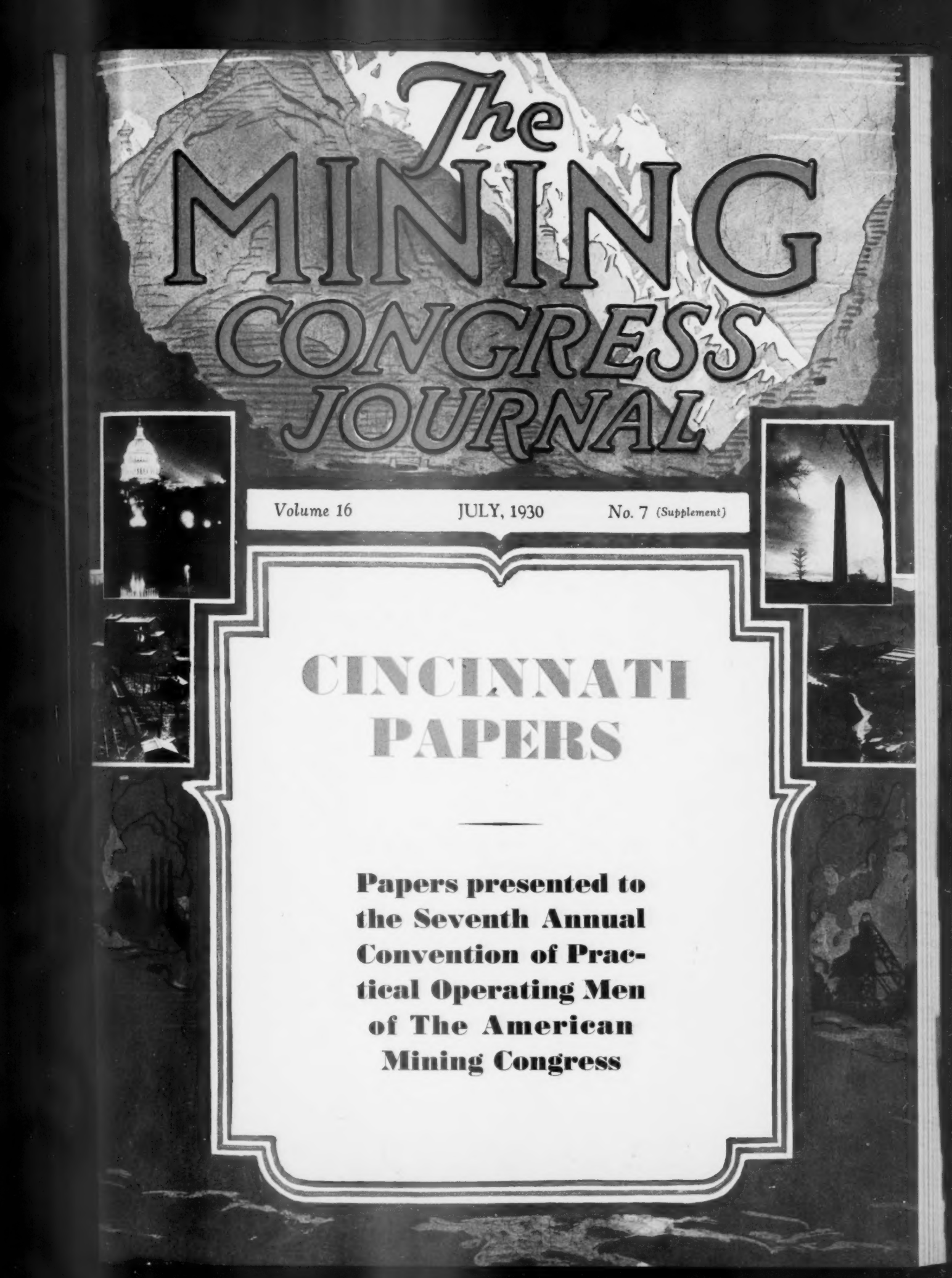

Volume 16 JULY, 1930 No. 7 (Supplement)

CINCINNATI PAPERS

Papers presented to the Seventh Annual Convention of Practical Operating Men of The American Mining Congress

THE Leahy

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First at the Mines

At the Show—you found the Leahy No-Blind Vibrating Screen and the Deister-Overstrom Diagonal Deck Coal Washing Table first choice of most practical coal operating men. At the Mines you'll find that from the standpoint of efficiency, capacity and operating cost, they have proven their right to the title.

The Leahy No-Blind Screen sizes coal with amazing speed. Quick, clean-cut separation, low operating cost, simplicity and long life are its features.

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The DEISTER CONCENTRATOR COMPANY

Incorporated 1906

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to suit conditions of *to-day!*
Menzies Hydro-Separators

To serve cleaning plant operators more efficiently and to secure for them a greater portion of BETTER CLEANED coal, Menzies Hydro-Separators have been developed in Double and Triple Cell Units, allowing for many rewashing arrangements and making this superior coal cleaning method available on all sized coals and in all capacities. Send for Bulletin No. 127.

Power and Gravity Car Dumpers

Improved designs—automatic operating devices—labor saving economies and typical RandS rugged construction are features of RandS Car Dumpers. Made in sizes to suit all conditions and in gravity and power driven types. Two current bulletins, No. 124 Shaft Type Gravity Car Dumpers and No. 129 Power Driven Rotary Car Dumpers, sent on request.

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Arms Screens, retaining the old advantages of minimum slope, low power requirement, accurate sizing and simplicity of design—plus the new double sash screen feature—are the logical selection of all cleaning plant operators. Arms Screens are made by coal mining engineers for coal screening. Send for a copy of Bulletin No. 122.

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Late developments in side wing construction and new type Marcus Drive Heads make these units the outstanding equipment for the hand picking of lump and egg sizes. Available, integral with retarding conveyors and apron or belt loading booms, in sizes up to 14′ 6″ wide and 175′ long, for sizing up to 800 tons per hour. Blueprints and details on request.

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Operators everywhere are availing themselves of RandS Engineering Service—over 1,400 contracts successfully handled in the past quarter century—witnessing the acceptance accorded RandS design. You can profit by allowing these specialists in coal cleaning, preparing and handling to submit plans on the new tipples or the modernizing of old ones. The experience of over 1,400 coal mine contacts is reflected in each plan submitted, be it large or small, a complete cleaning plant or just a conveyor addition—and RandS offers "Consultation Without Obligation".

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The MINING CONGRESS JOURNAL

VOLUME 16 | JULY, 1930 | No. 7 (Supplement)

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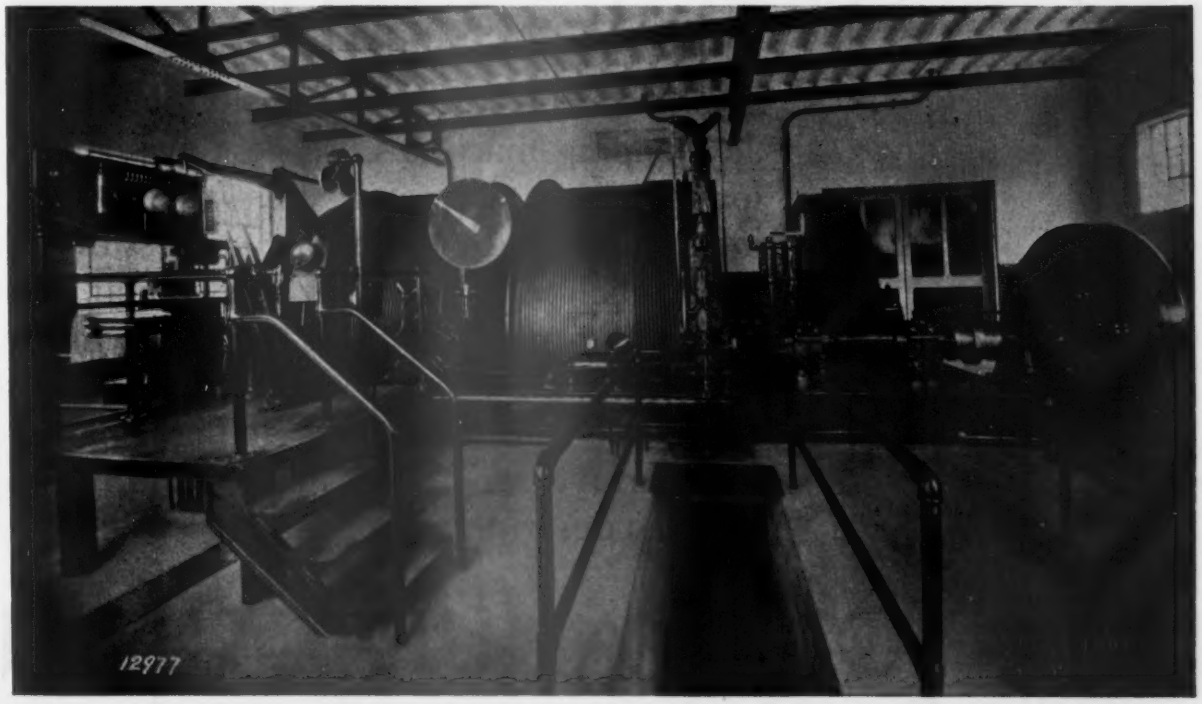
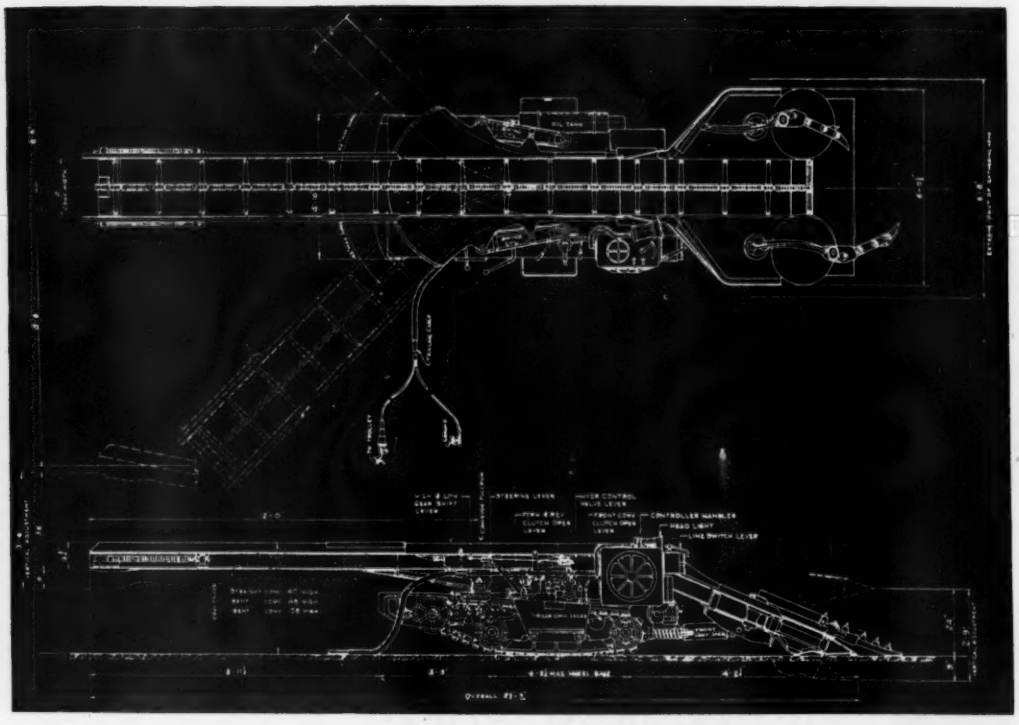
VULCAN MINING EQUIPMENT

covers every important phase of up-to-date production. Write for catalogs of types of equipment in which you are interested. Our engineering staff will be glad to consult with you about your problems.

VULCAN IRON WORKS
WILKES-BARRE, PENNA.

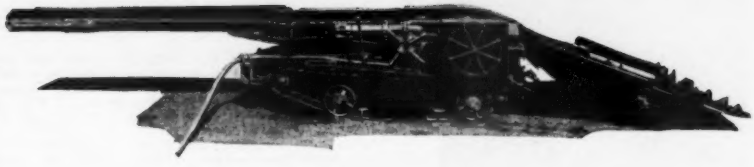
The 900 H. P. VULCAN tight and loose drum electric hoist shown below is installed at No. 2 shaft of the M. A. Hanna Company at Williamstown, Pa. Drums are 14' diameter; rope speed is 1,500 f.p.m.; size of rope, 1⅝" diameter; brakes are 13' 11" diameter, 15" wide; weight of car, 4,500 lbs.; weight of coal, 8,000 lbs.; weight of cage, 12,000 lbs.; weight of rock, 12,000 lbs.; motor 900 H. P., 360 R. P. M.





The 7-BU

JOY



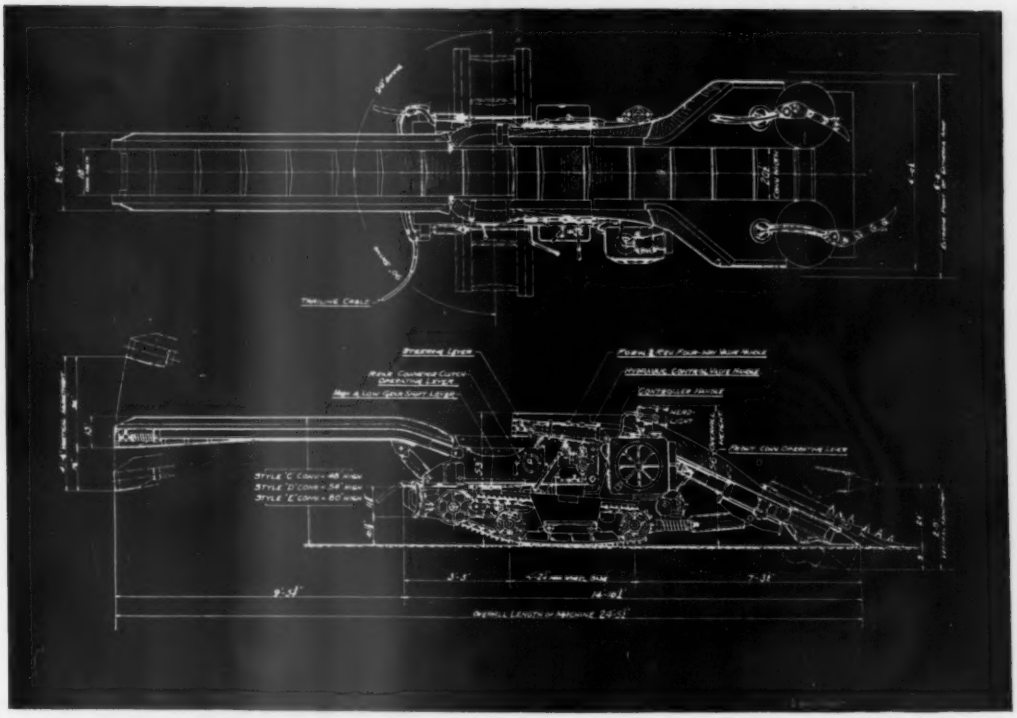
for low coal

The powerful, sturdy and easily handled Joy loading machines are now available for low coal. The new Joy 7-BU is 40 inches high and will operate successfully in a 48-inch seam. It is entirely similar in its loading mechanism, its one-man control and its capacity, to its larger brother. Its unique feature is its single flight flexible conveyor. Send for further information and descriptive literature.

The plan above shows operating principles, location of controls, conveyor flexion, and offers a comparison with the better known 5-BU loader shown in the plan on the opposite page.

JOY MANUFACTURING

The 5-BU



JOY

for high coal

The high loading records maintained by the Joy 5-BU loaders under many conditions are well known to the coal industry. Joy machines are responsible for the majority of the mechanically loaded coal in this country. The 5-BU loader is the machine that has established this record. It is made in standard or permissible types. Let us send you operating records, descriptive literature and names of companies near you where Joys are operating.

The flexibility and easy one-man control of the Joy 5-BU are shown in the plan above. These machines are guaranteed to load two tons per minute. We shall be glad to survey the possibilities for Joy loaders at your properties.

G COMPANY, Franklin, Penna.

50-ton Heisler owned by Northern Illinois Coal Corporation handling three cars, each weighing 78 tons loaded. On this operation, grades vary from level to 4 percent against the load—exceeding 4 percent in some short lengths.

You know why!

In the past three years, coal strippers have bought more Heislers than all other locomotives combined

The reason is no secret: The modern Heisler hauls Bigger Tonnages, with Lower Costs for Fuel and Upkeep.

This locomotive is put in on your work with the DEFINITE GUARANTEE to haul at least 30 percent more, ton for ton of locomotive. And to do it regardless of track conditions—on rough and "wavy" track with grades and sharp curves, as well as on straight level hauls.

You can *haul more* with the Heisler

The Heisler has a higher starting torque—its faster piston speed is a big advantage on heavy hauling. Its free-swiveling trucks have a flexible action that keeps every wheel always in contact with the rail, delivering full driving power. Hauls much more—accelerates faster and smoother.

You'll see many improvements on the modern Heisler that add to the hauling power, and assure all the speed required for the longer runs.

Will be glad to send you full description of this powerful locomotive—write us.

HEISLER LOCOMOTIVE WORKS, ERIE, PA.

HEISLER 182

GEARED LOCOMOTIVE

STEAM, GAS-ELECTRIC, OIL-ELECTRIC

One of 7 Heislers used on stripping operations of Lehigh Navigation Coal Company.

32-ton, 48-inch gauge Heisler handling four heavily loaded 10-yard dump cars on 4½ percent grade, for the Haddock Mining Co., Candlemas Collieries, Silverbrook, Pa. The 25-ton rod engine previously used on this grade handled only two cars.

The greatest gain of any type of mechanical loaders!

FIGURES released at the Cincinnati Convention revealed the tremendous advances pit car loading has made. We quote:

"The surprise has been in the greatly extended use of pit car loaders. From only 523,000 tons handled by pit car loaders in 1926, the tonnage increased to 4,117,000 tons in 1928. In 1929, however, pit car loaders accounted for 14,979,000 tons, a gain of 263.8 per cent over the preceding year."

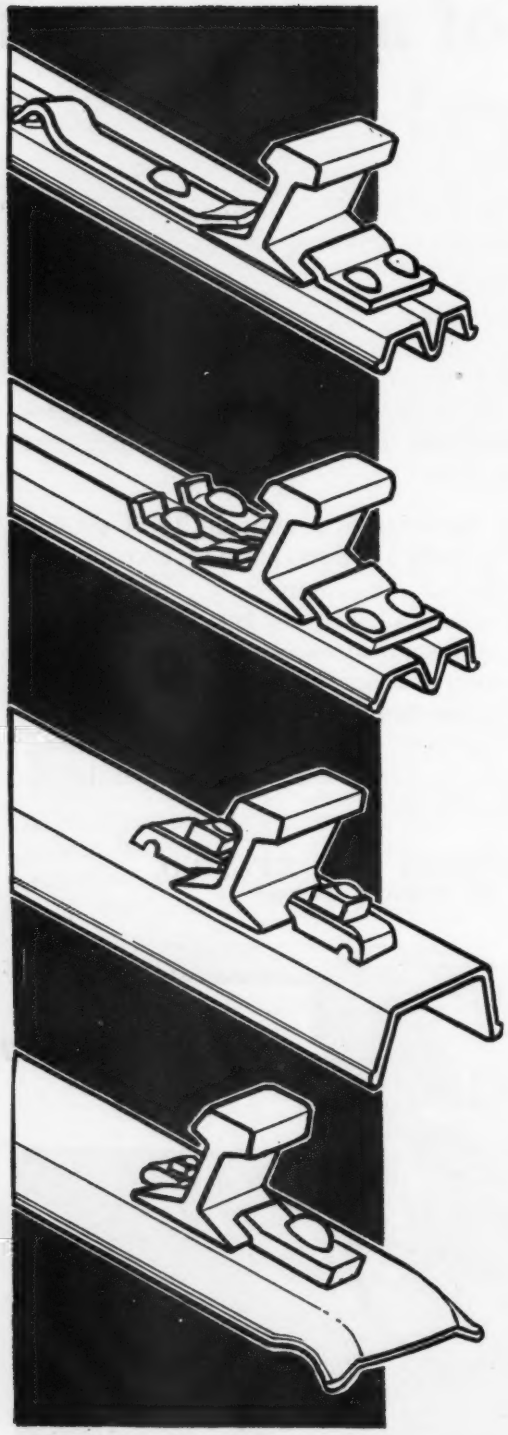
This is proof of the eminent practicability of pit car loaders. They are mobile, adaptable and easy to use. They speed up output at a minimum cost. The new Mt. Vernon Pit Car Loader embodies the best in this type of machine. Made in several sizes, it is light in weight, simple in construction and operation, with small power requirements. This machine has several unique operating advantages—its easy handling, two-side control, roller chain—which we would like to explain in detail. Write for descriptive bulletin.

MT. VERNON CAR MFG. CO.
MT. VERNON, ILLINOIS

Below is shown the folding forward truck which is a distinct advantage in handling. Note the simplicity of construction. Such details as the controls on both sides, "Z" bar frame, roller chain and fully protected parts with easy accessibility help to give this machine its practical operating advantages. Write for details.

Embodying the best in pit car loading

MT. VERNON . . . . PIT CAR LOADERS



A Copper Steel Tie
for Every Purpose

M19A TIE is designed for room work. It is only 11/16″ deep, and shallow depth is an item of importance in low seems of coal. Its width of 4¼″ provides a substantial bearing surface. A workman can easily carry a bundle of six as M19A weighs only 2½ pounds per foot. The illustration shows No. 26 rail clip inside and No. 26 AA outside. Arrangement and type of clips are optional.

M26A is our most popular general purpose tie and is of the same design as M19A, but larger and heavier. 13/16″ deep, 4¾″ wide, 3¼ pounds per foot. Double clips No. 26K are shown with this tie. However, either M19A or M26A are supplied with single or double locking clips as preferred.

M20 TIE is designed for more permanent track in main entries. M20 is 2″ deep, 6″ wide, and weighs 6 pounds per foot. This same type is available in two other weights: M18—1½″ deep, 5″ wide, 4.2 pounds per foot, and M27, described below. No. 23 rail clips, inside and out, are illustrated. These clips are separate from the tie. Locking clips, riveted on, can be furnished.

M27 TIE is for heavy duty service. 2¼″ deep, 7″ wide and weighing 9 pounds per foot, this tie will accommodate rails up to 85 pounds per yard. The recent trend toward heavier equipment has made M27 widely popular. Ends may be crimped on any Carngie Ties if desired. No. 23 inside clip and No. 120 outside clip are illustrated.

All Carnegie Ties are made of Copper Steel, thus greatly retarding corrosion and insuring the maximum length of service. A copy of our Light Rail and Mine Tie Catalogue will be sent at your request.

CARNEGIE STEEL COMPANY

Subsidiary of United States Steel Corporation

PITTSBURGH, PA. 30

CARNEGIE
COPPER STEEL MINE TIES

The "BIG FIVE"

At Cincinnati the attention of more than 3,000 practical coal operating men was centered on the big problems of mechanization — loading, hoisting, car handling. And, at Cincinnati, these men found five prime movers on display — the "Big Five" of coal mining equipment:

Brownies for car loading and handling, for hoisting and pumping— Brownies for heavy duty or light— for service, long, hard and dependable.

Send for any or all of bulletins 10, 17, 18, 19, 20, 21, 22 and 23

1. "The BROWNIE" Hoist —handles trips of cars past the loading point easily, without locomotive or crew. Controlled manually or remotely, it is sturdy, simple, fool-proof and dependable. Bulletin 20.

2. "The BROWNIE" Portable Electric Hoist—a powerful and sturdy room hoist, explosion-tested and approved by the U. S. Bureau of Mines—completely enclosed, insuring safe and efficient operation. Bulletins 10 and 17.

3. AUSTIN-BROWNIE Mine Gathering Pump—a single cylinder double acting piston pump, built in three sizes to meet various operating requirements—readily portable, highly efficient, self lubricating. Bulletin 21.

4. "The BROWNIE" Portable Mine Car Loader—for use in rooms, pillars, and narrow places. Light and portable, with two men it easily loads 40 to 60 tons a day. Bulletin 18.

5. "The BROWNIE" Car Retarder— for positive and safe control of car movement. Adapted to lowering trips of cars past loading heads of scrapers or conveyors, or to gravity movement of cars at tipple. Bulletin 19.

THE BROWN COMPANY FAYRO

JOHNSTONWN, PENNA.

THE BROWN COMPANY FAYRO

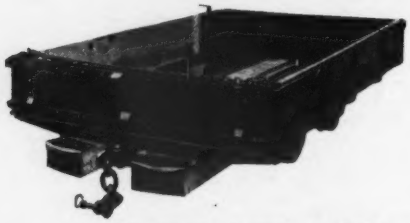
We cannot raise the market price for coal

but—

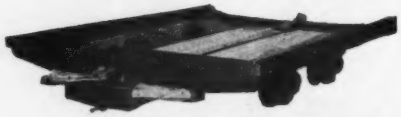
a careful study will frequently show many positive factors that will *achieve the same result*—reduce production costs. A slight change in car design may increase capacity, enough to reduce haulage costs a few cents per ton — make fewer cars and less car movement necessary, thereby adding materially to profits. Sometimes greater stamina and sometimes better bearings will turn the trick. Again cars may not meet unusual conditions properly. We take great interest in trying to discover new opportunities for improving haulage. Our booklet, "Lower Haulage Cost Higher Net Profit," tells some of our ways of working, describes our products, carries convincing testimony, and gives good suggestions. Let us send it.

Perhaps savings such as these are possible for you

Twenty of these cars hauled 200,000 tons in two years. There were several wrecks on an incline. Yet not a cent was spent for repairs. These cars were built to fit conditions.



This car was lowered 1½ inches with all other outside measurements retained. Five cubic feet capacity was gained! A definite reduction in expenses.



This car was specially designed to fit difficult conditions. Every cubic inch of space works. 18 inches above rails it carries 1,125 pounds level full.

Many unusual haulage factors are explained in "Lower Haulage Cost Higher Net Profits." Send for a copy.

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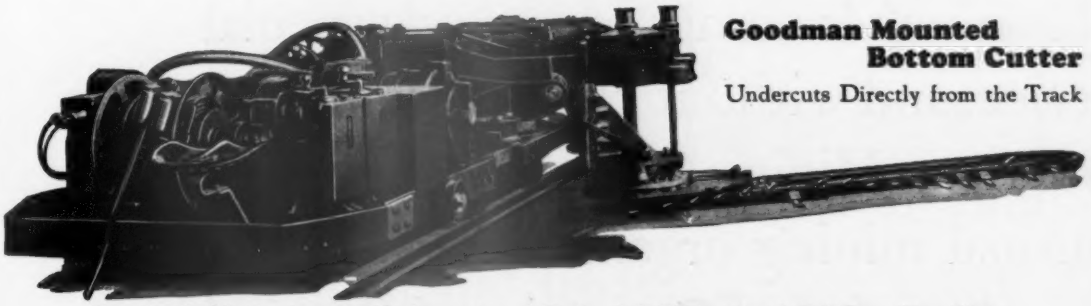
Pieces of Mining Equipment



Goodman Mounted Bottom Cutter

Undercuts Directly from the Track

Completely Mechanizes the Undercutting of Coal. A Self-Contained, Self-Propelling Unit.
Cutting Heights (bottom of kerf); from 8 in. below to 7½ in. above rail tops.
Cutting Widths (standard 7 ft. Cutter arm); 10 to 28 ft.

The New Goodman 6-ton 2-motor Low Vein Gathering Locomotive

24 in. Overall Height—Inside or Outside Frame—Electric cable reel; Generous roadway clearance; Large cab space for motorman, Standard speed—60 hp.; Slow speed—44 hp.; Wheelbase—44 in.; Central hung ball bearing motors; Split motor shells.

The New Goodman Universal Control Low Vein Shortwall

Overall Heights: 16 in. off truck
21 in. on truck

Power driven head and tail rope drums—both equipped with brakes. Each drum has *two* speeds and *both* speeds for *each* drum are variable Bottom bits are flush with bottom of machine—no scrapping. Extra large arc-shape passageway at side of machine releases cuttings quickly.

Illustrated Books { M-292—Mounted Bottom Cutter
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The association's contacts with the industry make it possible to perform for you, through the convention—*an annual service.* These same contacts make it possible to perform for you, through the Journal,—*a monthly service*, bringing you the same type of papers as presented at the convention, the same type as published in this Proceedings Number.

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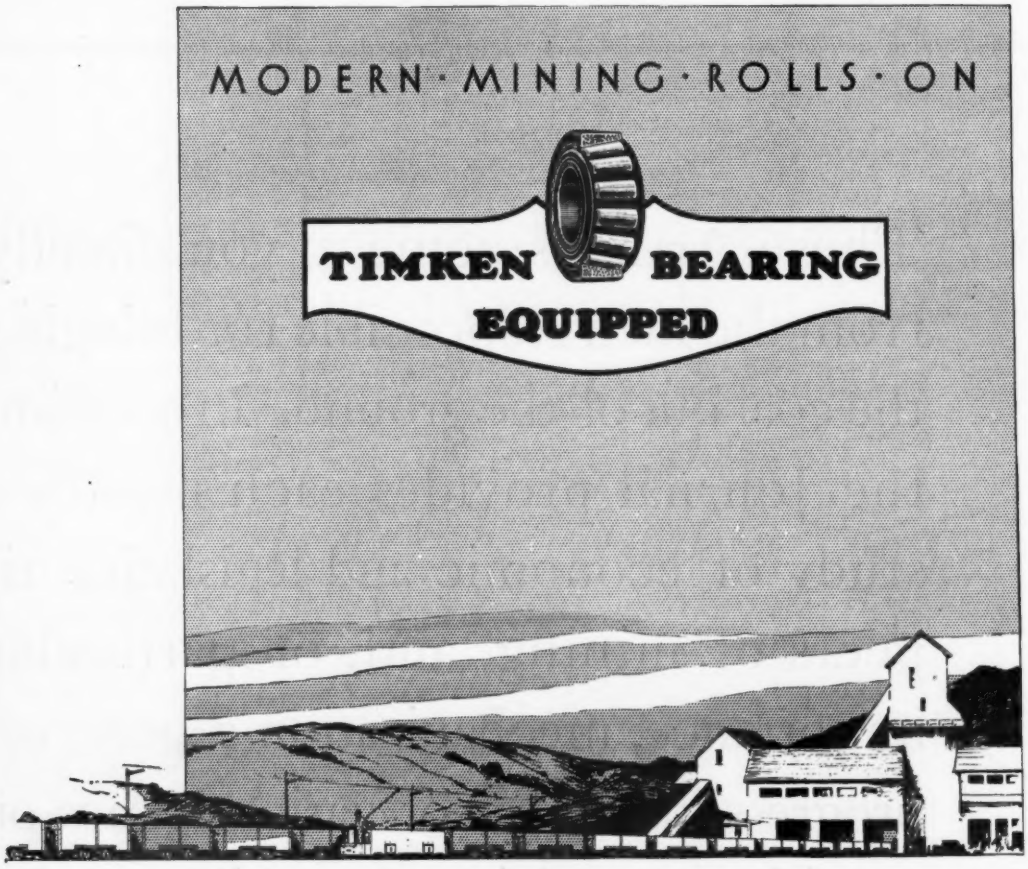
12 *regular issues* $3—*plus the Proceedings Number*

These Articles come to you directly from the men responsible for bringing the coal out of the ground. In addition the Journal provides each month a study of economic and legislative aspects of mining, and, of particular importance, mechanization reports on progress in the use of various types of machinery and its adaptability under specific conditions.

This Proceedings Number provides data on the outstanding accomplishments in the several coal mining fields for the period May 1929-1930.

The Journal is your contact with these several fields *from the close of one convention-exposition to the opening of the other.*

THE MINING CONGRESS JOURNAL
851 Munsey Bldg., Washington, D. C.



From Dawn To Dominance in Eight Years

EIGHT YEARS AGO Timken Bearings were first offered to mine operators as a relief from mine-car troubles. TODAY there is hardly a mine operator in the country who is not enjoying Timken-equipped mine-car benefits.

For the intervening period has witnessed one of the most remarkable industrial transitions ever recorded—an entire industry rising in unanimous endorsement of a single product, as Timken, sweeping confidently on, convinced even the most cautious and conservative by a demonstration of anti-friction efficiency and economy previously unheard of that left no room for doubt.

Initial purchases of a few Timken-equipped cars were quickly followed by repeat orders for sharply increasing quantities—indicating the rising tide of approval as operator after operator discovered the full significance of Timken tapered construction, Timken positively aligned rolls and Timken-made steel.

Thus, individual acceptance soon became industry-wide demand, with the result that practically every new mine car now built is Timken Bearing Equipped. The number not so equipped is so small as to be negligible. Check up on this with some of the outstanding coal operators.

And Timken benefits have been extended in the same degree to electric locomotives, motors, loaders, pumps, blowers, conveyors, tipples, hoists, speed reducers and other mining equipment. The Timken Roller Bearing Company, Canton, Ohio.

TIMKEN *Tapered Roller* **BEARINGS**

AMERICAN
MINING CONGRESS
7th ANNUAL
CONVENTION
of Practical Coal
Operating Men
and
National Exposition
of Mining
Equipment

Seventh Annual Convention of Coal Mining Officials
The American Mining Congress

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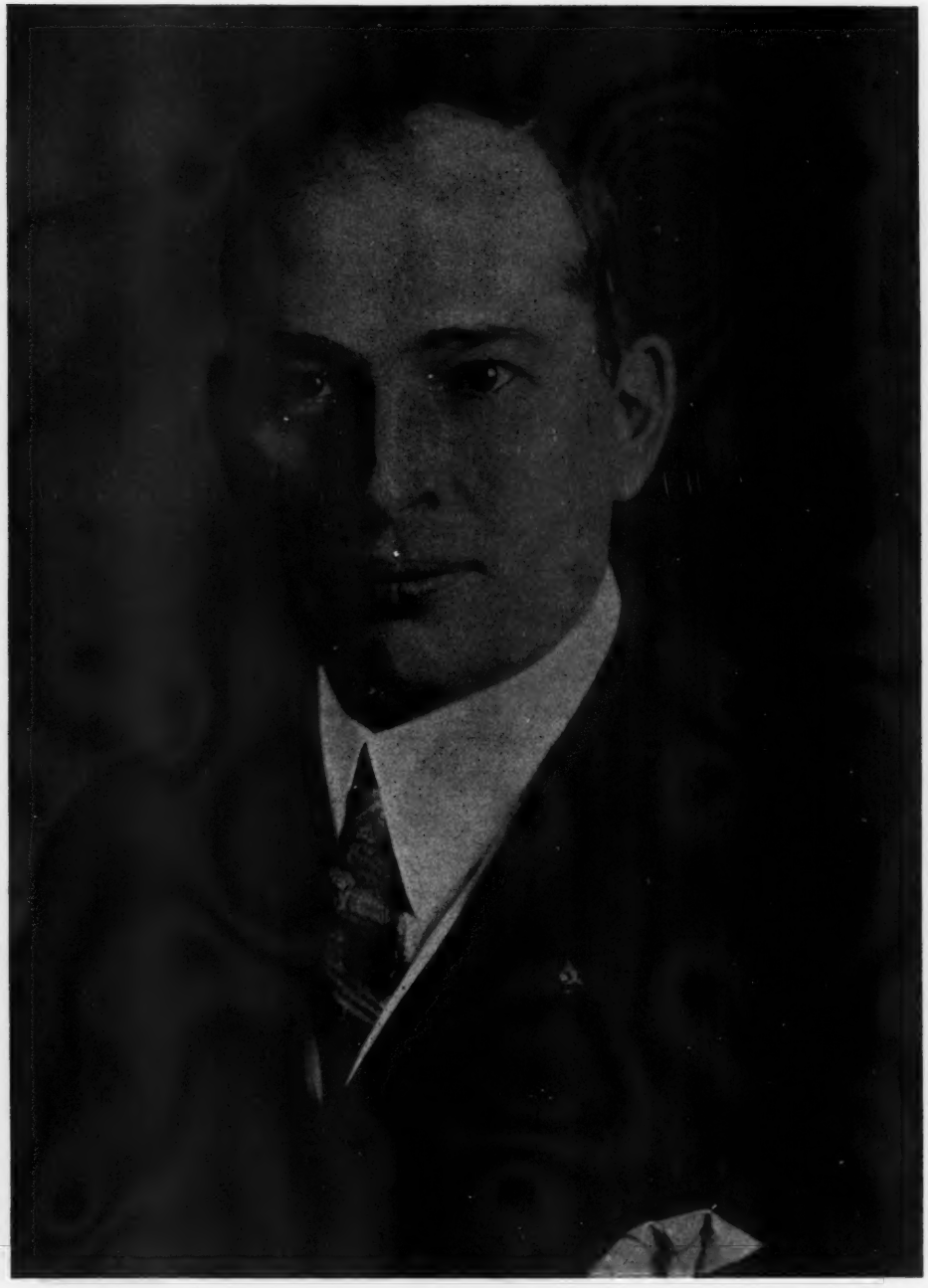

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Director of Exhibits, National Exposition of Coal Mining Equipment

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Chairman, Program Committee, Seventh Annual Convention, Practical Coal Operating Men

And Again—Cincinnati

IN the minds of the coal industry the word "Cincinnati" has come to have a much greater meaning than that of a mid-western city. It represents the greatest opportunity offered to the industry each year, to bring itself abreast with the rapidly growing tide of efficient production, safety and cooperative effort.

For at Cincinnati, each May, for the past seven years, coal operators have congregated in large numbers, have exchanged ideas, and have had displayed for them a magnificent exposition of equipment and supplies. Nowhere is there such an assembly of the operating personnel of an industry, and a presentation of efficiency-producing equipment with highly trained men whose sole aim is to explain how it may be adapted to production problems.

This meeting offers to the operator—which includes everyone concerned with the actual production of coal—an unusual opportunity to gain up-to-the-minute information upon such important subjects as mechanization, accident prevention, personnel training, and all other phases of their problems.

The meeting scheduled for the week of May 5 offers a wonderful opportunity to listen to papers presented by the best minds in the industry upon every phase of operation from blasting at the face to putting the coal into the railroad cars; to see the most magnificent display of equipment yet assembled; and to renew friendships, for every indication points to an attendance far in advance of other years.

The Cincinnati meeting is the most excellent example of the dawn of a new day in coal, the beginning of real cooperation between the various fields, companies and individuals.

The dates are May 5 to 9. The place is Music Hall, Cincinnati; the sponsoring organization is The American Mining Congress.—*Editorial, May,* 1930, *Issue* THE MINING CONGRESS JOURNAL.

Monday, May 5, 9 a. m.

Registration of Delegates

Inspection of Exhibits

Monday, May 5, 2 p. m.

OUTSTANDING DEVELOPMENTS IN COAL IN 1929-30

CHAIRMAN: DR. L. E. YOUNG
Vice President, Pittsburgh Coal Company

"Mechanized Mining"
By G. B. SOUTHWARD, *Mechanization Engineer, The American Mining Congress.*

"Statistics on Mechanized Mining"
By F. G. TRYON, *Head, Statistics Section, Coal Division, U. S. Bureau of Mines.*

"Developments in Anthracite"
By ELI T. CONNER, *Consulting Engineer, Scranton, Pa.*

"Developments in Fuel Utilization"
By HOWARD N. EAVENSON, *of Eavenson, Alford & Hicks, Pittsburgh.*

"Developments in Strip Mining in the United States"
By K. A. SPENCER, *Charge of Engineering, Pittsburg & Midway Coal Mining Company.*

"Developments in Mining Machinery in the United States and Europe"
By W. H. RASTALL, *Chief, Industrial Machinery Division, U. S. Department of Commerce.*

Tuesday, May 6, 9 a. m.

MECHANIZED MINING

CHAIRMAN: R. L. IRELAND, JR., *Manager, Bituminous Mines, M. A. Hanna Company.*

"Coal Cutting with Track Machines and General Face Preparation"
By GEO. F. CAMPBELL, *General Manager, Old Ben Coal Corporation.*

Discussion

"Gathering Methods Developed for Mechanized Loading"
By R. J. OLDHAM, *Superintendent, Centralia Coal Company.*

Discussion
CHAS. GOTTSCHALK, *Big Vein Coal Company.*
G. C. MCFADDEN, *Peabody Coal Company.*

"Power in Mechanical Mining"
By CARL LEE, *Electrical Engineer, Peabody Coal Company.*

Discussion
F. L. STONE, *General Electric Company.*

"Keeping Costs and Statistics In Connection With Mechanized Loading"
By W. L. AFFELDER, *Vice President, Hillman Coal & Coke Company.*

Discussion

Tuesday, May 6, 2 p. m.

TRANSPORTATION AND MAINTENANCE

CHAIRMAN: F. R. LYON, *Vice President, The Consolidation Coal Company.*

"Large Locomotives in Long Haulage"
By G. G. KANABLE, *Chief Electrical Engineer, Rochester & Pittsburgh Coal Company.*

Discussion
CHAS. M. MEANS, *Consulting Engineer, Pittsburgh, Pa.*

PROG

THE AMERICAN MINING CONGRESS

PRACTICAL COAL

MUSIC HALL, CINCINNATI,

"Increasing Capacity of Mine Cars"
By F. S. FOLLANSBEE, *Chief Engineer, The Koppers Coal Company, Inc.*

Discussion

"Anthracite Stripping and Transportation"
By W. S. RAUSCH, *Mining Engineer, Lehigh Navigation Coal Company.*

Discussion

"A 100 Percent Mechanical Loading Operation"
First showing of the moving picture film of the Wildwood operation, Butler Consolidated Coal Company
Presented by W. P. VANCE, *Chief Engineer and General Superintendent, Butler Consolidated Coal Company.*

Wednesday, May 7, 9. a m.

PERSONNEL TRAINING

CHAIRMAN: MILTON H. FIES, *Vice President, in Charge of Operations, DeBardeleben Coal Corporation.*

"Vocational Training Among Coal Mine Employes"
By DR. J. J. RUTLEDGE, *Chief Mine Engineer, Maryland Bureau of Mines.*

Discussion
W. D. BRENNAN, *Utah Fuel Company.*
CHAS. ENZIAN, *Consolidation Coal Company.*
R. M. LAMBIE, *Department of Mines, of West Virginia.*
H. E. NOLD, *Ohio State University.*
C. E. LAWALL, *School of Mines, W. Va. University.*

"Training Men at Face"
By F. E. BEDALE, *Engineer of Safety, Consolidation Coal Company.*

Discussion
J. W. BISCHOFF, *West Virginia Coal & Coke Company.*
J. A. LONG, *Woodward Iron Company.*
S. W. BLAKSLEE, *Pennsylvania Coal & Coke Corporation.*
E. J. CHRISTY, *Wheeling Township Coal Mining Company.*

"Developing Bosses and Coaching Men"
By GOMER REESE, *General Superintendent, Kemmerer Coal Company.*

Discussion
H. S. GILBERTSON, *Lehigh Navigation Coal Company.*

Awarding of Jos. A. Holmes' Safety Certificate to Sheridan-Wyoming Coal Company—Presentation by J. J. Forbes, U. S. Bureau of Mines

Wednesday, May 7, 2 p. m.

MECHANIZED MINING (Thin Seams)

CHAIRMAN: D. D. DODGE, *General Superintendent, W. J. Rainey, Inc.*

"Entry Development with Conveyors"
By JOHN H. RICHARDS, *Chief Mining Engineer, Wheeling & Lake Erie Coal Mining Company.*

Discussion

GRAM

EVENTH ANNUAL CONVENTION
PERATING OFFICIALS

NNATI, IO, MAY 5-6-7-8-9, 1930

"Conveyors in Room and Pillar Operations"
By GEO. J. KREBS, *Supt., Reading Iron Co.*

Discussion
M. D. COOPER, *Hillman Coal & Coke Company.*
L. H. SCHNEER, *Consolidation Coal Company.*

"Mechanized Mining in Alabama"
By D. A. THOMAS, *President, Montevallo Coal Mining Company.*

"Long Face and Long Wall Mining Methods"
By EARL H. MCALPINE, *Mining Engineer, Haileyville, Okla.*

Discussion
C. A. GRIFFITH, *Pruden Coal Company.*

Thursday, May 8, 9 a. m.

MECHANIZED MINING (In High Coal)

CHAIRMAN: W. J. JENKINS, *Vice President and General Manager, Consolidated Coal Company of St. Louis.*

"Development and Operation with Mechanical Loaders in Illinois"
By T. J. THOMAS, *President, Valier Coal Company.*

Discussion
OTTO HERRES, *Utah Fuel Company.*

"Development and Operation with Mechanical Loaders in West Virginia"
By H. B. HUSBAND, *General Manager, Fuel Mine Operations, Chesapeake & Ohio Railway Company.*

Discussion

"Operation with Conveyors"
By F. W. WHITESIDE, *Chief Engineer, Victor-American Fuel Company.*

Discussion
G. A. BROWN, *Union Pacific Coal Company.*

"Mechanical Loading for Rock Work Through Caved and Filled Areas"
By SHELDON JONES, *Efficiency Engineer, Lehigh Valley Coal Company.*

Thursday, May 8, 2 p. m.

CLEANING COAL

CHAIRMAN: R. E. TAGGART, *Vice President, Stonega Coke & Coal Company.*

"Cleaning Coal at the White Oak Coal Co."
By W. E. TISSUE, *Assistant Sales Manager, White Oak Coal Co.*

Discussion

"Cleaning Coal at Central Indiana Coal Co."
By WM. H. STEWART, *General Superintendent, Central Indiana Coal Company.*

Discussion

"Cleaning Coal at Consolidation Coal Co."
By ROBERT RIGHTMIRE, *Engineer of Tests, Consolidation Coal Company.*

"Cleaning Anthracite Coal"
By PAUL STERLING, *Mechanical Engineer, Lehigh Valley Coal Company.*

"Cleaning West Virginia Coal"
By R. H. KELLEY, *Greenbrier Coal & Coke Company.*

Discussion

Friday, May 9, 9 a. m.

ACCIDENT PREVENTION

CHAIRMAN: A. J. MUSSER, *Vice President, Clearfield Bituminous Coal Corporation.*

"Methods Employed in Developing, Maintaining and Enforcing Safety Codes"
By A. S. WILSON, *General Superintendent, Boone County Coal Corporation.*

Discussion
ARTHUR POLLOCK, *Ford Collieries Company.*
WALTER H. GLASGOW, *Secretary of Mines of Pennsylvania.*
R. L. HAIR, *Colorado Fuel & Iron Company.*

"Relation of Mechanical Mining to Safety"
By A. W. DICKINSON, *Mining Engineer, The American Mining Congress.*

Discussion
J. D. ZOOK, S. W. BLAKSLEE, E. A. SIEMON, EDW. BOTTOMLEY, F. S. PFAHLER, J. W. STEDELIN, THOS. G. FEAR, E. J. CHRISTY, FRANK HILLMAN, C. A. MCDOWELL, EDGAR L. TAIT, OTTO HERRES.

"Physical Examinations in Relation to Accident Prevention"
By T. E. LIGHTFOOT, *Engineer in Charge of Accident Prevention and Compensation, The Koppers Coal Company, Inc.*

Discussion
WM. ROY, *Wheeling & Lake Erie Coal Mining Company.*
D. D. DODGE, *W. J. Rainey, Inc.*

"The Safety Award Winners (How They Do It)"
By (*Bituminous*) *Hull No. 33 Mine, De Bardeleben Coal Corporation.*
(*Anthracite*) *Highland No. 6 Mine, Jeddo-Highland Coal Company.*

"Rock Dust Practice"
By D. L. BOYLE, *Superintendent of Mines, Penelec Coal Corporation.*

Friday, May 9, 2 p. m.

MECHANIZED MINING (100 Percent Mechanized)

CHAIRMAN: IRA CLEMENS, *President, The Commercial Fuel Company.*

"A 100 Percent Pit Car Loader Operation"
By F. S. PFAHLER, *Vice President and General Manager, Superior Coal Company.*

Discussion
J. S. MCKENVER, *Kanawha & Hocking Coal Company.*
H. G. CONRAD, *Knox Consolidated Coal Company.*

"A 100 Percent Scraper Operation"
By C. R. STAHL, *Division Superintendent, C. C. B. Smokeless Coal Company.*

Discussion

"A 100 Percent Mechanical Loading Operation"
Moving picture film of the Wildwood operation, Butler Consolidated Coal Company
Presented by W. P. VANCE, *Chief Engineer and General Superintendent, Butler Consolidated Coal Company.*

COAL'S CONVENTION and EXPOSITION

May 5 to 9, 1930

Cincinnati, Ohio

The papers presented to the Seventh Annual Convention of Practical Coal Operating Men, represent a symposium of up-to-the-minute data on the operating problems of the Coal industry. These papers are presented in full in this issue of The Mining Congress Journal.

The Editors.

Auspices

MANUFACTURERS DIVISION
THE AMERICAN MINING CONGRESS

MECHANIZED MINING

By G. B. Southward *

THE purpose of this report is to show the lines along which mechanized loading is being developed, and the data which is here submitted covers 230 mechanized mines located in the principal coal fields of the United States. This does not include every mine in this country that is using mechanized loading but it is believed that there are a sufficient number of operations in this list to present a fairly comprehensive description of coal mine mechanization as it exists today. The figures given here deal only with the number of mines and the number of mechanized loading units in operation and do not include tonnage figures. The tonnages now being produced with the different types of equipment show the extent to which the mechanized production has increased over preceding years and that growth or increase shows what may be expected in the future. It is of equal interest and importance to determine, if possible, the trend which mechanization is following and this can best be done by a study of the uses of the different types of equipment, and the extent to which each type is being operated in the different fields and under different seam conditions.

In attempting to determine this trend there must be a number of factors taken into account such as the type of equipment or combinations of two or more types, the thickness of the seams mined, and the percentage or extent to which the loading is mechanized under these conditions. Geographical location also has had some influence on the developments and in *Table No. 1* the mines are divided into the following five fields:

(1) THE CENTRAL FIELD—*Including* Indiana, Illinois, *and* Western Kentucky.

(2) THE NORTHERN APPALACHIAN FIELD—*Including* Ohio, Pennsylvania, Maryland, *and* Northern West Virginia.

(3) THE SOUTHERN APPALACHIAN FIELD—*Including* Southern West Virginia, Virginia, Eastern Kentucky, *and* Tennessee.

(4) THE SOUTHERN FIELD—*Including* Alabama, Arkansas, *and* Oklahoma.

(5) THE ROCKY MOUNTAIN FIELD—*Including* Montana, Wyoming, Utah, Colorado, *and* New Mexico.

The tonnage increases which were made during the last year are a direct evidence of the success of mechanized loading as it is hard to believe that there would be so great a production mined from purely experimental operations. There may be some question, however, as to what percentage of the mines that are now using loading equipment are experimental and what percentage have proven the equipment to be more economical than hand loading. It would be difficult to answer this question with absolute accuracy but from the figures which we have there can be a very close approximation given. This would be based on the extent or percentage to which each of these mines have adopted mechanized loading and have discarded hand work. It is a safe assumption that a mine which is 100 percent mechanized has proven its economy to the satisfaction of the management and it is equally true that a mine which has mechanized as much as 90 percent of its loading can be considered as successfully proven and definitely committed to complete mechanization. It is probable that most mines which are more than 50 percent mechanized are successful but in order to eliminate any doubt or question, the higher figure of 90 percent has been used in this report.

The determination of the number of mines which are on an experimental basis is a matter of some doubt but this report has assumed that the operations are experimental in which the total output of the mines is less than 10 percent mechanized. This is not quite true as there are individual cases where one unit has been installed and found successful but the additional equipment has not been put in operation although it is the intention of the management to do so. To balance against this there are mines which are more than 10 percent mechanized that are still experimental and it is very probable that the number of these will approximately off-set any errors made in the first assumption.

The mines which are more than 10 percent and less than 90 percent mechanized, include some which are successful, some in which the success is not yet proven and a comparatively few that are unsuccessful and where some change is likely to be made. There is no attempt in this article to divide the mines in this class since their analysis would be entirely a matter of opinion and could not be supported by any figures which we have on hand.

The geographic location of the mine appears to have had quite a little effect in the adoption of mechanized loading. A summary of the operations shows the following divisions:

CENTRAL FIELD—*74 mines with 47 mines 90 percent mechanized.*

NORTHERN APPALACHIAN FIELD—*55 mines with 7 mines 90 percent mechanized.*

SOUTHERN APPALACHIAN FIELD—*22 mines with 2 mines 90 percent mechanized.*

SOUTHERN FIELD—*32 mines with 20 mines 90 percent mechanized.*

ROCKY MOUNTAIN FIELD—*47 mines with 11 mines 90 percent mechanized.*

Keeping in mind that these figures do not show the number of hand loading mines in each of these fields this table will indicate the degree of success with mechanization that is being had in the different sections of the country. The reasons for the unequal rate of development being made in the different fields is in some cases due to the physical conditions of the seams, in some cases due to the labor situation and in others it is due to the market requirements. It is probably true that the difficulties in any one field are about the same as in the others although the difficulties may be of a different class and in the final analysis it is the need for economies over hand loading that determines the effort made by the operators to adopt mechanization as a means for lowering their mining costs. A comparison of the development in the different fields with the various types of equipment is made in *Table 2.*

A very interesting trend is the number of mines using two or more different types of machines. This is given in *Table 3* showing that 181 of the 230 mines use only one type of machine but 45 mines have 7 different combinations of two types of equipment, and 4 mines have combinations of three types. The success of these is indicated by the fact that over 50 percent of the mines using combinations are more than 90 percent mechanized. This is a higher percentage than in the single type operations where 62 out of the 181 or approximately one-third are 99 percent mechanized. In other words the use of two or more kinds of loading equipment does not seem to be at all experimental and following are a number of examples of where it has been found advisable to use two different types of equipment in the same mine.

(a) In pillar recovery where it is not considered advisable to subject expensive equipment to the roof hazards and a less expensive type of machine is used in the pillar work.

(b) In some mines there will be panels so nearly worked out that territory suitable for a large unit production is not possible and in such cases smaller type machines are installed to reduce the overhead cost.

(c) In mines where the seam height is subject to considerable variation it is found advisable to install different types of machines to suit the varying heights of the coal.

(d) Where it is necessary to develop one or two isolated entries a cheaper type of machine may be more suitable than a larger type used in the production areas.

(e) A mine using a long face method may require different types of equipment for the face work and for the entry development.

(f) Certain mines have men who are not adaptable to machine operation but can be used as hand shovelers with conveyors or pit car loaders.

In order to show the extent of the development under different seam heights with the different types of equipment there are four tables submitted with this article assembling the information from *Table 1* and breaking it up in several ways. Each of these tables shows the relations between several factors and it is necessary to study all four for a correct understanding of coal mine mechanization now in operation.

* Mechanization Engineer, The American Mining Congress.

TABLE NO. 1
Mechanized Mines and Equipment Units in Operation

CENTRAL FIELD
Illinois—Indiana—Western Kentucky

Types of equipment	Number of mechanized mines	Number of equipment units	Number of mines classified by percentages of mechanized loading 90%	—90%	—10%	Number of mines in various seam heights +6 ft.	+4 to 6 ft	—4 ft.
Mechanical Loaders	15	106	11	3	1	12	3	..
Pit Car Loaders	43	1,341	25	14	4	29	14	..
Mechanical Loaders and Pit Car Loaders	15	132 421	11	3	1	11	1	..
Mechanical Loaders, Pit Car Loaders, and Scrapers	1	1 1 2	..	..	1	..	1	..
TOTAL	74	2,004	47	20	7	55	19	..

NORTHERN APPALACHIAN
Pennsylvania—Maryland—Ohio—Northern West Virginia

Mechanical Loaders	6	29	4	2	..	5	1	..
Pit Car Loaders	7	41	..	3	4	4	3	..
Conveyors	26	69	..	15	11	..	2	24
Scrapers	11	54	3	6	2	..	1	10
Conveyors and Scrapers	3	6 6	..	3	..	..	..	3
Mechanical Loaders and Pit Car Loaders	2	10 22	..	2	..	2	..	..
TOTAL	55	237	7	31	17	11	7	37

SOUTHERN APPALACHIAN
Southern West Virginia—Virginia—Eastern Kentucky—Tennessee

Mechanical Loaders	13	21	..	12	1	13	..	..
Pit Car Loaders	1	6	..	..	1	..	1	..
Conveyors	6	15	2	2	2	..	1	5
Scrapers	2	5	..	1	1	..	..	2
TOTAL	22	47	2	15	5	13	2	7

SOUTHERN
Alabama—Arkansas—Oklahoma

Pit Car Loaders	3	33	..	1	2	3	..	..
Scrapers	1	4	..	1	..	..	..	1
Conveyors	15	43	8	6	1	1	2	12
Scows	4	9	3	1	..	..	..	4
Conveyors and Scows	3	6 3	3	..	..	..	..	3
Conveyors and Pit Car Loaders	5	20 39	5	..	..	1	..	4
Pit Cars Scrapers and Conveyors	1	22 3 3	1	..	..	..	1	..
TOTAL	32	185	20	9	3	5	3	24

ROCKY MOUNTAIN
Montana—Wyoming—Utah—Colorado—New Mexico

Mechanical Loaders	11	53	4	7	..	11	..	..
Pit Cars	4	33	1	3	..	2	2	..
Conveyors	10	18	1	6	3	4	3	3
Scrapers	3	6	..	2	1	2	..	1
Mechanical Loaders and Pit Car Loaders	1	3 7	..	1	..	..	1	..
Mechanical Loaders and Conveyors	3	6 13	..	3	..	2	1	..
Mechanical Loaders and Scrapers	2	5 4	..	2	..	2	..	.
Conveyors and Pit Car Loaders	9	39 15	3	5	1	4	5	..
Scrapers and Conveyors	1	1 1	..	1	..	1	..	..
Scrapers and Pit Car Loaders	1	2 2	.	1	..	..	1	..
Pit Car Loaders Conveyors and Scrapers	1	10 14 5	1	..	..	1	..	..
Mechanical Loaders Conveyors and Scrapers	1	1 6 1	1	..	..	1	..	..
TOTAL	47	245	11	31	5	30	13	4

TOTAL FOR UNITED STATES

	230	2,718	87	106	37	114	44	72

Table 3 shows the number of mines operating mechanized loading and the number of equipment units installed. The horizontal lines classify the mines according to the various types of equipment and show the number of units operating both where one type and where two or more types are in use. The vertical columns show the total number of machine units but in order to gauge correctly the relative importance of each type of equipment the tonnage which they produce should be taken into account. The tonnage figures are not available and in their absence an estimate can be made based on average productive capacities. This would list the types of equipment in the following order and ratio:

Mechanical loaders	45
Pit car loaders	40
Conveyors	10
Scrapers	5

Table 4 classifies in the horizontal lines the total number of 230 mines according to the one or several types of equipment used as was done in *Table 3*. The vertical columns separate the mines in two ways—by the thickness of the seams and by the percentage or extent to which the total output of the mines use mechanized loading. Thick seams are those greater than 6 ft. in height, medium seams are from 4½ to less than 6 ft., and thin seams are those less than 4 ft. This table shows that more than one-half of these operations are in seams having less than 6 ft. of coal and more than one-third of the mechanized mines are producing approximately their entire output with mechanized loading while only one-sixth of the total are producing less than 10 percent. It also shows that more than one-half of the mines using two or more types of loading equipment are completely mechanized while only one-twelfth of these are experimental or loading less than 10 percent.

Table 5 makes the same classifications in the horizontal divisions as in *Tables 3 and 4*. The vertical columns separate the mines into three divisions of high, medium, and low coal and further separates each of these two divisions into

TABLE NO. 2
Number of Mechanized Loading Mines and Types of Equipment in the United States

Total in U. S.		Central Field	Northern Appalachian	Southern Appalachian	Southern	Rocky Mountains
45	Mechanical loaders	15	6	13	....	11
58	Pit car loaders	43	7	1	3	4
57	Conveyors (including duckbills)	....	26	6	15	10
17	Scrapers	....	11	2	1	3
4	Scows (Arkansas)	....	....	....	4	....
18	Mechanical loaders and pit car loaders	15	2	....	....	1
3	Mechanical loaders and conveyors	....	....	....	....	3
2	Mechanical loaders and scrapers	....	....	....	....	2
14	Pit car loaders and conveyors	....	....	....	5	9
1	Pit car loaders and scrapers	....	....	....	....	1
4	Conveyors and scrapers	....	3	....	....	1
3	Conveyors and scows	....	....	....	3	....
1	Mechanical loaders, pit car loaders and scrapers	1	....	....	....	....
1	Mechanical loaders, conveyors and scrapers	....	....	....	....	1
2	Pit car loaders, conveyors and scrapers	....	....	....	1	1
230		74	55	22	32	47

TABLE NO. 3
Number of Mechanized Loading Units in Mines Operating One or More Types of Equipment

No. of Mines	Types of Mechanized Loading	NUMBER OF EQUIPMENT UNITS IN OPERATION Mechanical Loaders	Pit Car Loaders	Conveyors	Scrapers	Scows
45	Mechanical loaders	209	....	....	....	....
58	Pit car loaders	....	1,454	....	....	....
57	Conveyors (including duckbills)	....	....	145	....	....
17	Scrapers	....	....	....	69	....
4	Scows (Arkansas)	....	....	....	....	9
18	Mechanical loaders and pit car loaders	145	450	....	....	....
3	Mechanical loaders and conveyors	6	....	13	....	....
2	Mechanical loaders and scrapers	5	....	....	4	....
14	Pit car loaders and conveyors	....	54	59	....	....
1	Pit car loaders and scrapers	....	2	....	2	....
4	Conveyors and scrapers	....	....	[illegible]	7	....
3	Conveyors and scows	....	....	[illegible]	....	3
1	Mechanical loaders, pit car loaders, and scrapers	1	1	....	2	....
1	Mechanical loaders, conveyors, scrapers	1	....	6	1	....
2	Pit car loaders, conveyors and scrapers	....	32	17	8	....
230	Total	367	1,993	253*	93	12

* This number shows operating units and each operating unit usually includes one face and one haulage conveyor.

TABLE NO. 4
Percentage of Mechanized Loading and Thickness of Seams Mined

No. of Mines	Types of Equipment	Number of Mines and Percentage of Mechanized Loading +90%	−90% to +10%	−10%	Number of Mines in Various Seam Heights* Thick Seams	Medium Seams	Thin Seams
45	Mechanical loaders	19	24	2	41	4	..
58	Pit car loaders	26	21	11	38	20	..
57	Conveyors (including duckbills)	11	29	17	5	8	44
17	Scrapers	3	11	3	2	1	14
4	Scows	3	1	..	..	..	4
18	Mechanical loaders and pit car loaders	11	6	1	16	2	..
3	Mechanical loaders and conveyors	..	3	..	2	1	..
2	Mechanical loaders and scrapers	..	2	..	2	..	..
14	Pit car loaders and conveyers	8	5	1	5	5	4
1	Pit car loaders and scrapers	..	1	..	..	1	..
4	Conveyors and scrapers	..	3	1	1	..	3
3	Conveyors and scows	3	..	..	..	..	3
1	Mechanical loaders, pit car loaders, scrapers	..	..	1	..	1	..
1	Mechanical loaders, conveyors and scrapers	1	..	..	1	..	..
2	Pit car loaders, conveyors and scrapers	2	..	..	1	1	..
230	Total	87	106	37	114	44	72

* Thick seams are greater than 6 ft.; medium seams are from 4 to 6 ft., and thin seams are less than 4 ft.

the number of mines that have mechanized their loading more than 90 percent, less than 90 and more than 10 percent, and less than 10 percent. The horizontal lines by showing the number of mines that are completely or partially mechanized in each seam and percentage classification will indicate the adaptability of each type of equipment or combination of types to different seam heights. The vertical columns indicate the extent to which the different thicknesses of coal are mechanized with all classes of equipment. By comparing the figures for the totals of the vertical columns it will be seen that the seam thickness has had a marked influence on the development as 45 percent of the mechanized mines in high coal produce more than 90 percent of their output with mechanized loading. This percentage decreases with the thickness of the coal to 36 percent in the medium seams and 20 percent in thin seams.

The operations covered in this report are confined entirely to the bituminous fields as complete data on anthracite mining has not yet been compiled. The major trend in anthracite mechanization has been in low coal and seams less than 2 ft. in thickness are being successfully operated with mechanized loading. The earlier operations were with scrapers, but within the last few years there have been a number of installations with conveyors of all three types—shaking, chain, and belt. Conveyors and scrapers are used both in room and pillar work and in long face mining. Mechanical loaders are also used to some extent, but for the most part these are confined to rock work. The successful mechanized loading in thin veins has had the effect of increasing the reserve areas of minable anthracite and seams which were formerly considered too low for profitable hand operation are now being mined in successful competition with hand loading in the thicker seams.

TABLE NO. 5

Percentage of Mechanized Loading in Seams of Different Heights

No. of Mines	Types of Equipment	Number of Mines and Percentage of Mechanized Loading in Thick Seams			Number of Mines and Percentage of Mechanized Loading in Medium Seams			Number of Mines and Percentage of Mechanized Loading in Thin Seams		
		+90%	−90% to +10%	−10%	+90%	−90% to +10%	−10%	+90%	−90% to +10%	−10%
45	Mechanical loaders	17	23	1	2	1	1	..	..	..
58	Pit car loaders	16	15	7	10	6	4	..	..	..
57	Conveyors (including duckbills)	2	2	1	1	5	2	8	22	14
17	Scrapers	..	2	..	..	..	1	3	9	2
4	Scows (Arkansas)	..	..	..	..	..	..	3	1	..
18	Mechanical loaders and pit car loaders	11	5	..	..	1	1	..	..	..
3	Mechanical loaders and conveyors	..	2	..	..	1	..	..	..	..
2	Mechanical loaders and scrapers	..	2	..	..	..	..	..	..	..
14	Pit car loaders and conveyors	3	2	..	2	2	1	3	1	..
1	Pit car loaders and scrapers	..	..	..	..	1	..	..	..	..
4	Conveyors and scrapers	..	1	..	..	..	..	..	2	1
3	Conveyors and scows	..	..	..	..	..	..	3	..	..
1	Mechanical loaders, pit car loaders and scrapers	..	..	..	..	..	1	..	..	..
1	Mechanical loaders, conveyors and scrapers	1	..	..	..	..	..	..	..	..
2	Pit car loaders, conveyors and scrapers	1	..	..	1	.	..	..	..	..
230	Total	51	54	9	16	17	11	20	35	17

Lobby and Registration Desk at the 1930 Convention

Preliminary Report on Loading Machines and Conveyors in Bituminous Coal Mines in 1929

By O. E. Kiessling, F. G. Tryon *and* L. Mann

FROM 21,559,000 tons in 1928, the production of bituminous coal by "mechanized mining" increased to 37,862,000 tons in 1929—a growth of more than 75 percent.

Practically all phases of technological improvement in mining, such as cutting machines and electric haulage, are forms of mechanization. The discussion of "mechanization" now going on in the American coal industry, however, centers around the use of mechanical devices to reduce the labor of hand shoveling into mine cars, and the figures in this paper are designed to show how far the replacement of hand loading had progressed by the end of 1929.

Source of Information

The figures are based on information courteously furnished by the operators in their customary statistical reports to the Bureau of Mines. Each operator reported the number and types of machines and the tonnage loaded by each type. To make sure that every mine using mechanical loading devices was included in the survey, manufacturers of equipment were asked for lists of the mining companies to whom machines had been shipped. These lists were then checked with the operators' reports to the bureau. The totals presented herewith are subject to slight revision on receipt of final information from some companies with whom the bureau is still in correspondence. While the results incorporated in the following tables are believed to be as complete as a survey of this kind can be made, the bureau will appreciate immediate notification of any data that have been inadvertently omitted as well as suggestions for the improvement of the reports. The generous assistance of the industry in supplying information is gratefully acknowledged.

Summary for 1929

The tonnage of bituminous coal produced by mechanized mining in 1929 is summarized in *Table I*. The total of 37,862,000 tons relates only to operations underground. It does not include coal loaded by power shovels in strip pits which amounted to approximately 22,000,000 tons in 1929. Neither does it include anthracite, 3,427,000 net tons of which were loaded mechanically in 1929, according to the Pennsylvania Department of Mines.

It is also important to note that the figures in *Table I* represent production and not capacity. The total is undoubtedly much less than the annual capacity of the machines installed up to the end of 1929, partly because production seldom reaches theoretical capacity. Many of the machines used in 1929 were installed late in the year and so had little effect on the tonnage for 1929. For this reason the production by mechanical methods in 1930 will undoubtedly show an increase over the past year.

As shown by the top section of *Table I*, the total loaded by machines was 19,291,000 tons. This includes coal handled by all types of machines that eliminate hand shoveling except for incidental clean up. Of the total, mobile loading machines (including entry drivers) handled 16,432,000 tons, scrapers (including a small tonnage handled by scows) handled 1,550,000 tons, and self-loading conveyors (including shakers provided with duckbills, conveyors equipped with a cutting device, and certain others designed to receive the coal as shot down) accounted for 1,309,000 tons.

The data in the middle section of *Table I* cover conveyors. Including duckbills and other self-loading conveyors the total quantity handled by conveyors was 19,880,000 tons. Of this, hand-loaded conveyors accounted for 3,592,000 tons, and pit-car loaders for 14,979,000 tons. While the pit-car loader is often locally referred to simply as a "conveyor," in the Bureau's reports the latter term is reserved for devices which transport the coal for an appreciable distance.

From the recapitulation at the bottom of the table it will be seen that of the total tonnage handled mechanically, 43.4 percent was loaded by mobile loading machines, 4.1 percent by scraper loaders, 39.6 percent by pit-car loaders, and 12.9 percent by conveyors, including duckbills.

Increase by Types of Machines, 1928-29

In comparison with 1928, the total mechanized tonnage increased more than 75 percent. *Table II* shows which of the types of machines have contributed most of this increase. The tonnage handled by mobile loading machines increased 39.1 percent. Scrapers just held their own, while duckbills (including other types of self-loading conveyors) showed an increase of 9.1 percent. The figure given under the item "duckbills and other self-loading conveyors" is a composite; because of the necessity for so combining the data, a substantial increase in tonnage handled by duckbills is partially offset by the declining importance of other types of self-loading conveyors.

The surprise has been in the greatly extended use of pit-car loaders. From only 523,000 tons handled by pit-car loaders in 1926, the tonnage increased to

TABLE I.—TONNAGE OF BITUMINOUS COAL PRODUCED BY MECHANIZED MINING IN 1929

	Net tons	Percent
Loaded by machine:		
Mobile loading machines	16,432,000	85.2
Scraper loaders	1,550,000	8.0
Duckbills and other self-loading conveyors	1,309,000	6.8
Total loaded by machine	19,291,000	100.0
Handled by conveyors:		
Duckbills and other self-loading conveyors	1,309,000	6.6
Pit-car loaders	14,979,000	75.3
Other hand-loaded conveyors	3,592,000	18.1
Total handled by conveyors	19,880,000	100.0
Recapitulation, less duplications:		
Mobile loading machines	16,432,000	43.4
Scrapers	1,550,000	4.1
Pit-car loaders	14,979,000	39.6
Conveyors, including duckbills	4,901,000	12.9
Grand total, mechanized mining	37,862,000	100.0

TABLE II.—COMPARATIVE INCREASE IN TONNAGE HANDLED BY THE PRINCIPAL TYPES OF MACHINES, 1928 TO 1929

	1928 Net tons	1929 Net tons	Increase Net tons	Increase Percent
Mobile loading machines	11,811,000	16,432,000	+4,621,000	+39.1
Scraper loaders	1,548,000	1,550,000	+2,000	+.1
Duckbills and other self-loading conveyors	1,200,000	1,309,000	+109,000	+9.1
Total loaded by machines	14,559,000	19,291,000	+4,732,000	+32.5
Pit-car loaders	4,117,000	14,979,000	+10,862,000	+263.8
Other hand-loaded conveyors	2,883,000	3,592,000	+709,000	+24.6

4,117,000 tons in 1928. In 1929, however, pit-car loaders accounted for 14,979,000 tons, a gain of 263.8 percent over the preceding year.

For the first time figures are presented in *Table II* permitting a comparison of the tonnage loaded by hand-loaded face conveyors over a two-year yeriod. From 1928 to 1929, the quantity handled by this type of equipment increased 709,000 tons, or 24.6 percent.

Increase by Types of Machines, 1926-29

The trends in tonnage handled by the principal types of machines over the past four years are well illustrated by *Figure 1*. The steady rise in mobile loading machines is shown by the upper curve. Pit-car loaders, however, are today running mobile loading machines a close second, due particularly to the rapid rise of the former between 1928 and 1929. Duckbills and other self-loading conveyors have been increasing but at a slower rate. Scrapers have just about held their own, decreasing between 1926 and 1928, but showing a slight gain in 1929. Hand-loading face conveyors have made notable gains, as shown by the curve for the two-year period, 1928-29.

For loading machines proper, the comparison may be carried back to 1923. The tonnage loaded by mobile machines, scrapers, and duckbills and other self-loading conveyors has been as follows.

Year	Net tons	Year	Net tons
1923.....	1,880,000	1926.....	10,022,000
1924.....	3,496,000	1928.....	14,559,000
1925.....	6,148,000	1929.....	19,291,000

Accurate figures on pit-car loaders are not available for the years prior to 1926, and data on the tonnage handled by hand-loaded face conveyors were obtained for the first time in 1928.

Distribution of Pit-Car Loaders

The rapid rise of pit-car loaders has already been referred to, and *Figure 2* shows the distribution of this type of equipment throughout the various coal fields. It will be noted that pit-car loaders are used over a surprisingly wide area, but that the principal concentration occurs in the thick coals of Illinois, Indiana, and in the Pittsburgh bed of southwestern Pennsylvania. They also have made a vigorous start in western Kentucky, and there is a sprinkling in the Rocky Mountain States.

Distribution of Hand-Loaded Face Conveyors

The regions in which the pit-car loader has made small headway have frequently installed face conveyors, and it is of interest to note how closely these types of equipment, which both require a certain amount of hand shoveling, complement each other. As shown in *Figure 3*, hand-loaded face conveyors are noticeably absent in Illinois, Indiana, and in the Pittsburgh bed. On the other hand, they are used extensively along the eastern fringe of the Appalachian fields, from Alabama northward, with an unusually heavy con-

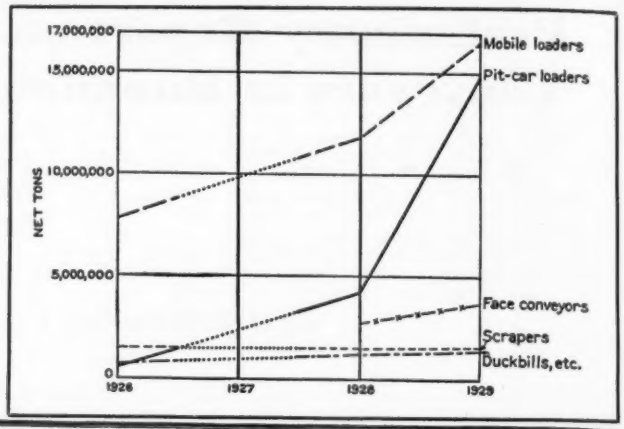

Figure 1. Increase in tonnage loaded, by types of machines, 1926 to 1929.

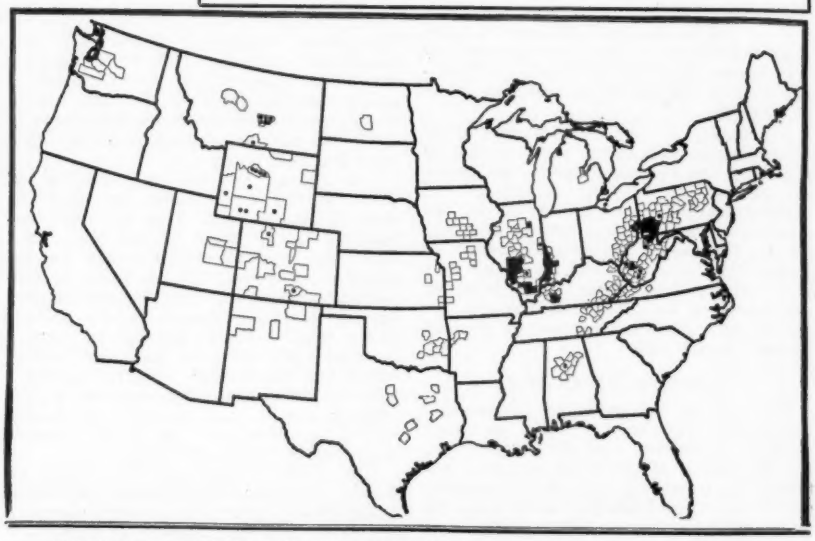

FIGURE 2. TONNAGE OF BITUMINOUS COAL HANDLED ON PIT-CAR LOADERS IN 1929

The map shows in outline all the important coal-producing counties. In any county from which operators reported tonnage loaded on pit-car loaders there is at least one black dot no matter how small the quantity. A large number of dots indicates a larger tonnage and in some cases the number of dots is so great that the county appears solid black.

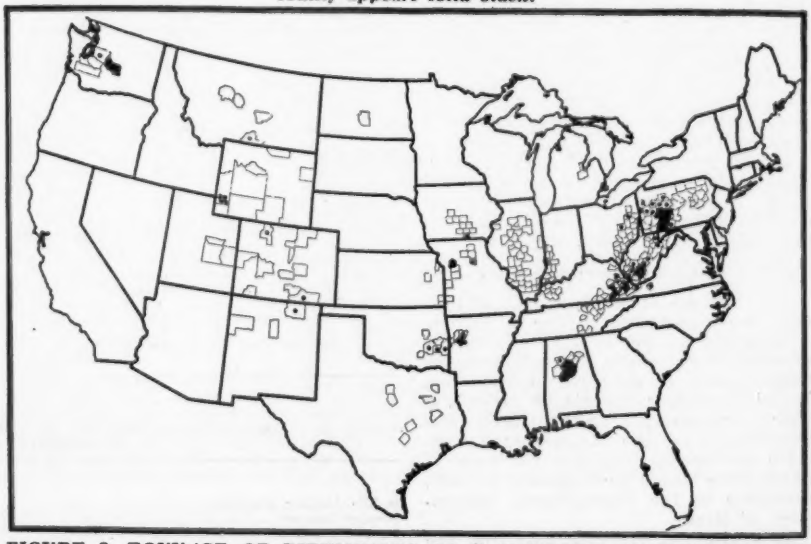

FIGURE 3. TONNAGE OF BITUMINOUS COAL HANDLED ON HAND-LOADED FACE CONVEYORS IN 1929

The form of presentation is the same as in the preceding diagram. The areas of greatest concentration are along the eastern edge of the Appalachian fields, particularly in Alabama and in the Cambria and Somerset areas, Pennsylvania. In the far west, heaviest concentration appears in the Roslyn field, Kittitas County, Wash.

centration in the Cambria and Somerset areas of central Pennsylvania. In the west, face conveyors are commonly used in the Roslyn field of Kittitas County, Washington.

Increase in Mechanical Loading by States

Relative gains in mechanical mining were widespread in 1929 and each of the principal states showed an increase over the preceding year. *Table III* traces the growth in each of the important states for the two-year period and covers all types of loading equipment, including pit-car loaders and hand-loaded face conveyors. As a group, the Northern States show the largest increase, with the gain of 161.8 percent in Illinois, due mainly to the increased use of pit-car loaders, heading the list. For Indiana and Pennsylvania the increases were 35.0 percent and 57.9 percent, respectively.

With the exception of the large gain of 92.9 percent recorded for Montana, the Western States did not show a continuation of the same rate of growth that characterized the period from 1926 to 1928. Each of the Southern States listed showed a notable increase, ranging from 23.2 percent in West Virginia to 52.1 percent in Alabama, although the proportion of the total output mechanically loaded in any one of these states is still small.

At this point it should be noted that the item covering "other states" includes a considerable tonnage mechanically loaded in Ohio. This coal is produced by a limited number of companies that load a large proportion of their output mechanically. Until such a time as it is advisable to show this figure separately, it is necessarily included with the tonnage from other states. Out of fairness to the coal industry of Ohio, however, it should not be overlooked that mechanization has made considerable progress in the mines of that state.

Total Production With All Types of Machines, by States

The first two columns of *Table IV* shows the tonnage handled by loading machines proper and the tonnage shoveled by hand on pit-car loaders or conveyors. The last column gives the total produced with all types of machines. Illinois, with 18,252,000 tons, ranks first in the total tonnage mechanically mined, followed by Pennsylvania, Indiana, Wyoming, and West Virginia, in the order named.

Rank of States in Percent of Output Mechanized

As in immediately preceding years, Wyoming leads all other states in the percent of its total output produced by mechanized mining. Fully 45.3 percent of the deep-mined output of Wyoming was mined mechanically, of which 39.9 percent was loaded by machine and 5.4 percent handled on pit-car loaders or hand-conveyors. Next in rank came Montana, with a total of 36.0 percent mechanically mined, followed by Illinois and Indiana with 30.4 percent and 26.4 percent, respectively. In Utah 17.5 percent of the deep-mined output in 1929 was loaded by machine.

In the Appalachian and the southern fields the percentage mechanically mined was much smaller. In Virginia, for example, it was 7.5 percent; in Pennsylvania, 3.0 percent; and in Kentucky, 1.3 percent.

For the country as a whole the percentage of the deep-mined output mechanically mined was 7.1 percent in 1929 as against 4.5 percent in the preceding year.

Number of Machines in Use

The total number of machine-loading devices in use in 1929 was 713, of which 488 were mobile loading machines, 126 were scrapers, and 99 were duckbills or other self-loading conveyors. These figures do not include machines used for experimental purposes only or machines installed in mines that were idle throughout the year.

The total number of pit-car loaders in use during 1929 was 2,521, and conveyors (other than pit-car loaders) were used in 130 mines.

Mechanical Loading and Engineering Progress

The present extent of mechanical loading is not in itself an adequate index of the use of machinery in American coal mines. The commercial application of the loading machine is a recent development and represents only one phase of the broad technological progress that has characterized the art of coal mining in the past 15 years. This period has witnessed the rapid electrification of mine power and haulage and a great increase in the use of cutting machines. Corresponding advances have been made in preparation practice on the surface. Machine loading has been a relatively late step in the general trend. The net result of the changes is seen in the increasing output per worker. In 1928 the production per man per day averaged 4.73 tons, an increase of 1.12 tons in the 15 years since 1913. In the 15 years before 1913 the increase was only 0.52 ton.

TABLE III.—INCREASE IN TOTAL TONNAGE MECHANICALLY MINED, 1928-1929

State	1928	1929	Increase	
			Net tons	Percent
Illinois	6,971,000	18,252,000	11,281,000	161.8
Indiana	2,426,000	3,274,000	848,000	35.0
Pennsylvania	2,682,000	4,234,000	1,552,000	57.9
Wyoming	2,682,000	3,002,000	320,000	11.9
Utah	878,000	920,000	42,000	4.8
Montana	367,000	708,000	341,000	92.9
Kentucky	598,000	812,000	214,000	35.8
West Virginia	2,190,000	2,698,000	508,000	23.2
Virginia	794,000	984,000	190,000	23.9
Alabama	614,000	934,000	320,000	52.1
Other States *	1,357,000	2,044,000	687,000	50.6
	21,559,000	37,862,000	16,303,000	75.6

* Ohio, Colorado, New Mexico, Arkansas, Tennessee, North Carolina, Oklahoma and Washington.

TABLE IV.—TOTAL TONNAGE PRODUCED BY LOADING MACHINES, PIT-CAR LOADERS, AND CONVEYORS IN 1929, BY STATES

State	Loaded by machine	Handled on pit-car loaders and hand-loaded conveyors	Total produced by mechanized mining
Illinois	6,545,000	11,707,000	18,252,000
Pennsylvania	1,925,000	2,309,000	4,234,000
Indiana	2,000,000	1,274,000	3,274,000
Wyoming	2,647,000	355,000	3,002,000
West Virginia	2,049,000	649,000	2,698,000
Virginia	816,000	168,000	984,000
Alabama	107,000	827,000	934,000
Utah	920,000	.....	920,000
Kentucky	451,000	361,000	812,000
Montana	555,000	153,000	708,000
Other States	1,276,000	768,000	* 2,044,000
Total	19,291,000	18,571,000	37,862,000

* Ohio, Washington, Arkansas, Colorado, Missouri, New Mexico, Maryland, Tennessee, North Carolina, Oklahoma, and Iowa.

TABLE V.—RANK OF STATES IN PERCENTAGE OF TOTAL BITUMINOUS DEEP-MINED OUTPUT PRODUCED BY MECHANIZED MINING IN 1929

State	Percentage loaded by machine	Percentage handled on pit-car loaders and hand-loaded conveyors	Total percentage mined mechanically
Wyoming	39.9	5.4	45.3
Montana	28.2	7.8	36.0
Illinois	10.9	19.5	30.4
Indiana	16.1	10.3	26.4
Utah	17.5	....	17.5
Virginia	6.2	1.3	7.5
Alabama	.6	4.7	5.3
Pennsylvania	1.4	1.6	3.0
West Virginia	1.5	.5	2.0
Kentucky	.7	.6	1.3
United States	3.6	3.5	7.1

Outstanding Developments in Coal . . . ANTHRACITE

By Eli T. Conner *

BEFORE presenting matters relating directly to mining practice and engineering activities, it seems desirable to make a rather hasty survey of the anthracite industry over a somewhat longer period than the years 1929 and 1930.

Anthracite in common with the bituminous industry in this country has been subjected to all kinds of "buffeting" and "harassment" in no way connected with the industry itself. Just to mention a few of the disturbing and dislocating features, it will be recalled that when the World War started in 1914, several of the major anthracite producing corporations were under fire by the Federal Government. Action by the Government was something that had been threatened for many years, i. e., the segregation from the transportation corporations of their coal mining properties and interests. These activities by the Government, as is well known, resulted within several years in complete segregation of mining activities. This necessarily meant reorganizations of various natures and realignment of all of the activities except perhaps the direct mining and preparation work.

Anthracite began to feel the effects of the great World War about the middle of 1916 and when this country later joined in the conflict, and passed the conscription law, the possible effect upon this essential industry was not fully realized. Because of this lack of foresight by many of us, many men occupying "key" positions in and about the mines were called in the first draft. Most of them being patriotic American citizens were loathe to ask for exemption, consequently the efficiency of the operating staffs was perceptibly affected by the loss of those young, energetic "key" men. This draining of the best men from the region was in subsequent draft calls measurably corrected.

One of the most serious blows to the anthracite industry was that brought about by the action of the United States Fuel Administrator. It will be recalled that the Department of Fuel Control was inaugurated by the Federal Government effective September 1, 1917. In an endeavor to ration anthracite, the fuel administrator confined the territory to which it might be distributed to a comparatively limited area in the Northeastern part of the United States and a certain area in Canada. Practically all of the territory to the westward of Buffalo, where for many years a considerable volume of anthracite had been regularly marketed, was arbitrarily closed to this fuel. As a war measure this action was doubtless necessary, but the later effect, after the war was over, has been extremely serious to the industry as a whole. Anthracite producers had for many years prior to 1917 devoted much attention and expended large sums in capital outlay for the extension of its market to the middle west. It also had for years been the practice during the open season on the Great Lakes to store large quantities of anthracite at Duluth and other points on the Upper Lakes for distribution to markets further west by rail in the winter.

All of this market was cut off by order of the United States Government and much of it has been permanently lost.

The anthracite industry, both operators and employes, responded patriotically to every call of the Government during the World War. Notwithstanding the handicap above mentioned, its contribution to the cause in which we were all interested was impressive.

I mention these things as a preliminary to the principal subject of my paper. Subsequent to the war, as is well known, the period of readjustment has been long and trying. Relations between employer and employe were the subject of much discussion and controversy. The emergency wage scales of the war period were confirmed by formal agreement in 1920, but were again brought in question in 1922, resulting in a suspension or strike of about six months. Again in 1923 questions were raised and additional demands made by the employes, which resulted in a 10 percent increase in wages upon suggestion by Governor Pinchot, of the State of Pennsylvania. Again in 1925, questions were raised which resulted in another suspension or strike, extending from September, 1925, to the latter part of February, 1926. During this period of discussion and dissension, similar experiences were had in bituminous mining. These questions constantly arising pertaining to the supply of fuel to the public, resulted in action by Congress and the Federal Government, and the designation of the United States Coal Commission, headed by John Hays Hammond, with instructions to investigate anthracite and bituminous mining and to report thereon. The deliberations of this commission and the results of these investigations have been published in pamphlet form by the Federal Government. These volumes contain much information of a historical nature that will doubtless hereafter be found of value as works of reference, but the effect upon the industry and upon the relations between employer and employe has been of practically no value.

During all of this period, i. e., from the middle of 1916 to the middle of 1926, the market demand for anthracite was in excess of the actual producing capacity of the mines. In consequence of this, salesmanship was not necessary and consequently was neglected. For decades prior to 1926, a large section of the consuming public, together with the producing corporation in the anthracite region, and their employes, talked about and believed that anthracite was a necessity, and because of the fact that it is produced in such a comparatively limited area—almost a natural monopoly—the question of marketing need not disturb the producers or their employes. Those charged with the responsibility of anthracite production were due for a rude awakening. The strike of 1925-1926, which was the longest on record, and which was precipitated in the fall, forced the consuming public all over the northeastern part of the United States and Canada to learn how to keep warm with substitutes. It will be recalled that under the advice of John Hays Hammond, who was then engaged upon the investigation before mentioned, all of the governors of the New England States met and took measures for the supply of fuel to the people of their states. Their recommendations and the agitation of the subject convinced many former users of anthracite that there was collusion between the State of Pennsylvania in the enactment of its tax upon authracite; the controllers of the corporations in the anthracite region; and the United Mine Workers and their members to so limit the supply of anthracite that the prices could be raised to exorbitant and outrageous figures. The feeling of resentment in the minds of most people in the consuming territory was further added to by lack of care upon the part of anthracite producers in the preparation of the product.

In consequence of what I have referred to, the demand for anthracite commencing with the fall period of 1926 has been less than the capacity of the mines. For many years prior to 1915 the demand and the output of anthracite grew in about the same proportion as the increase in population in the northeastern part of the United States and Canada, but for the past five or six years, there has been no appreciable growth or increase in demand, notwithstanding the fact that the population continues to increase at its normal rate.

It seems desirable to consider what has just been presented, in order to get a picture of conditions existing during the past two or three years. When in 1927 and 1928 it was found that the "sellers market" of the previous 10 years had disappeared, it became a question of quality and service, as well as salesmanship, and anthracite producers were compelled to make radical changes in their methods

* Consulting Mining Engineer, Scranton, Pa.

and practices. Without exception they have taken the lesson to heart and have increased their sales forces and their service departments, and are vigorously and aggressively competing for their own, throughout the territory for many years supplied to a large extent with this incomparable fuel for domestic uses.

In the department of preparation, which I won't say had been neglected, because there always had been more attention devoted to preparation than in other competitive fuels, and during the past three years, all of the producers in the anthracite region, realizing the necessity of satisfying a critical market, have made strides in the improvement of the product. In this endeavor there have been numerous experiments and installations of devices that have come to the notice of producers during the past few years. The preparation of anthracite by jigs is something that is well known and need not now be referred to. The newer devices that have been tried, and to some extent adopted, are the Rheolaveur process, which has been installed at several breakers in the anthracite region, as well as some bituminous operations; the Hydrotator, which is, up to the present, used for reducing the ash in the small sizes of coal only; the Menzes jig, used for the same purpose, and the method known as the Chance sand flotation process. This device has been adopted by 37 producers in the anthracite region who have installed 68 units or cones of the Chance device. This process has been well described before the Mining Congress so that I need not go into it in detail. Within the past two years there have been installed under my supervision, as consulting engineer to the Hudson Coal Company, at its Marvine and Gravity Slope breakers six units, and a third four-cone plant now under construction at Powderly. They are successful in the matter of minimum ash going to the market; maximum ash in the reject; and maximum all around efficiency as compared with any other device, together with an equal cost as compared with jig preparation. It has been found that while there is some economy in operating labor, maintenance cost of a Chance plant is higher than that of a jig plant by reason of the abrasive effects of the sand. The consumer is well satisfied with coal cleaned by the Chance process.

The most outstanding development in anthracite during the past two or three years is the extensive and ambitious plans projected by the Philadelphia and Reading Coal and Iron Company, as announced in the annual report for the year 1928. This corporation, as is well known, owns and controls the largest reserve in the anthracite region and until recently was the largest producer. The management came under the direction of Mr. A. J. Maloney as president in the fall of 1927. At that time its product came from 44 mining operations and was prepared in 32 breakers. Much of the equipment was inadequate and uneconomical. The policy announced by the management was that preparation activities shall be centralized and modernized. In pursuance of this plan, a large central, fireproof breaker has been constructed at Locust Summit, Pa., and it is reported that this breaker is now in commission. The breaker is equipped with the Chance flotation process and is planned for the preparation of the output of several mines, with an expected daily production of about 12,000 tons marketable output.

In addition to the modernization of the department of preparation, the Philadelphia and Reading Coal and Iron Company announces that extensive electrification will be undertaken, and I am informed this program is now in progress.

The next most important development in the anthracite region during the past two or three years is the acquisition of all of the physical property of the Lehigh & Wilkes-Barre Coal Company by the Glen Alden Coal Company which became effective during the past year. This combination brings together two of the largest producers in the northern anthracite field. The properties of the two corporations were largely contiguous and the combined enterprise now embraces operations with a total annual capacity of about 14,000,000 tons. This makes the Glen Alden Coal Company, in point of annual capacity, the largest in the anthracite region, a position held for many years by the Philadelphia & Reading Coal and Iron Company.

During the past two years the Glen Alden Coal Company has installed at its Loomis Colliery the Rheolaveur process of separating impurities. This plant is now preparing about 5,000 tons per day with satisfactory results. This company has to a considerable extent adopted preliminary cleaning and heavy crushing in "head houses" situated on the ground, instead of doing this work, as in the past, at the head of the breaker. It has been found helpful and economical.

The Glen Alden Company has within the past few years adopted at many of its operations a plan of imparting a spreckled blue color to the coal as it leaves the lip screen of the breaker, and is loaded into the railroad car. By this means the Glen Alden coal is positively identified at its destination.

The Glen Alden Company has also installed at storage plants cleaning devices for brightening up the stored coal before shipment.

In the power department the Glen Alden Company has recently installed a Mercury converter for the purpose of converting a. c. power to d. c. power. Up to date this installation has been in an experimental stage, and it is not yet determined as to its complete success, though the advantages of eliminating the rotary converters by this means are great.

This company reports considerable improvement in the introduction of low velocity permissible powders, resulting in improvement in performance and yield in domestic sizes.

There has also been considerable extension by the Glen Alden Coal Company of its machine mining and loading activities, principally in thin beds.

The underground activities of the Hudson Coal Company during the past few years are of interest. During the past two years there has been introduced at its Powderly colliery what is known as the Schaefer lining. This is a German development which has been successfully used in mines in Germany, England, Belgium and France for some years past. It consists of flexible arch-work composed of specially designed concrete blocks. It is especially adapted to the support of broken roof conditions in crushed territory where difficulty is experienced to maintain mine openings with ordinary timber supports. The initial installation of this device was in territory where it was difficult and expensive to support a broken roof condition with a rigid type of timber installation. The principal advantage of Schaefer lining is the peculiarity of its design which results in a non-rigid, fire-proof, strong arch composed of specially designed concrete slabs. These slabs or blocks are made at the mine by a patented process and are of various sizes and shapes because of variations in the vertical and horizontal radii of the arch and sides. The weight is approximately 75 pounds per block, which assures convenience in making, handling and placing by a single person.

The lining used for the maintenance of ordinary mine openings is composed of a series of independent vertical rings successively constructed one against the other. The width of each ring is from 19 to 20 inches, which represents the measurement of the face of the ordinary concrete block. No mortar is used to bind either the blocks or rings together. The concealed side of each block is lug-shaped, through which a hole has been provided for the insertion of old wire rope to bind one block to the other. The remaining voids in these holes are then grouted to protect the steel binder from the action of the elements. The rings, which are generally more than a half circle, are placed on the bottom rock of the coal bed where floor conditions are secure. Compression blocks 2 in. thick and composed of creosoted yellow pine, are placed at suitable intervals in the ring between the concrete slabs as they are set in place. During the initial stages of roof pressure, the compression of these blocks allows the arch to yield without breaking and thus permits the relief of pressure which is necessary when heavy masses of strata settle or move. The relief of pressure thus insured enables the supported mass to settle until it becomes arched or self-supporting.

While the Schaefer lining as installed has been under observation for about a year and a half, it is believed that for the support of overburden under certain crushed mine conditions, it is more permanent and durable than any form of timber heretofore used in this region.

If any of the engineers present are interested in this subject further, there are photographs which can be seen of the installation described.

The Hudson Coal Company has continued its machine mining activities in beds of three feet and less in thickness. This practice was introduced about 15 years ago. During that time there has been a gradual increase in production so that by 1929 approximately 15 percent of the total output was won from beds between 20 and 30 ins. in thickness as compared with 2.8 percent experienced in 1916, and about 25 percent from beds of 36 ins. and less.

The greater part of this product is loaded by mechanical methods. Until recently the scoop loader has been almost exclusively used in transporting the freshly cut coal from the working face of thin beds to the mine car. However, its use was applied to chambers and long-wall faces regardless of whether the coal was cut by ordinary methods or blasted off the solid. There has recently been introduced instead of the scoop loader, to a limited extent, shaking chutes which are working satisfactorily. The shaking chutes are more adaptable to soft bottom conditions than is the scoop.

(*Continued on page* 27)

Developments in FUEL UTILIZATION

By Howard N. Eavenson *

As most of those attending this meeting are primarily interested in coal, this paper will be devoted to that class of fuels and will deal with other fuels only as they influence the use of coal.

The total amount of fuel used in the United States shows a steady growth, generally speaking, from year to year, with fluctuation depending upon business and labor conditions, while the consumption of coal has remained generally stationary since 1919. The increase in fuel use has been absorbed by the larger amounts of oil and natural gas used as fuel. *Table I* shows the consumption of each kind of fuel since 1919, with the equivalent coal figures for the total, the same data being shown on *Chart 1*.

The production of anthracite shows a gradual decrease during the period, against an almost uniform figure for bituminous coal, although both seem to have arrested, temporarily at least, the decline beginning in 1926. The production of coke, of low-volatile bituminous coal and of briquettes shows a gradual increase, while the curves of both natural and manufactured gas and of gas oil and fuel oil show an uninterrupted and steady rise. It is evident that low volatile coal, coke, oil and gas above all benefited somewhat from the lessened consumption of anthracite, and that both kinds of coal suffered from the increasing use of oil and natural gas.

Chart 2 shows the consumption of bituminous coal in public utility power plants and by railroads. The total consumption of coal by utilities has shown a practically steady rise during the period, while the unit per kilowatt-hour has shown a steady decrease, the average now being 1.69 lb. against 3.20 lb. at the beginning of the period. The best performance now is about 0.86 lb., so that the unit value can be expected to show a steady decrease for a number of years, although it is likely that the growth in the consumption of electricity will continue, as it has during the period, to overbalance the decrease in the unit figure.

The amount of locomotive fuel used by Class 1 railroads has remained practically stationary during the period, the figure for 1929 being slightly lower than that for 1919. The coal used in freight traffic per thousand gross ton-miles has shown a steady decrease during the period, and the average figure for 1929 of 125 lb. compares with the best figure reached of about 66 lb., so that this unit figure can be expected to decrease for probably the next 12 to 15 years. The coal used per passenger car-mile has also shown a steady decrease, and this can also be expected to continue for 10 to 15 years, so that it is not likely that the total fuel used for locomotives will increase in the near future; in fact, considering the electrifications now under way and proposed, it is quite likely that the total fuel consumed by the carriers will decrease during the next 8 or 10 years.

The use of pulverized fuel has shown a large increase during the period mentioned, and on *Chart 3* are curves showing the number of boiler horsepower installed and building at the end of each year mentioned, the last figures available being those of December 31, 1928. These figures show an amazing increase in the use of fuel in pulverized form, not only in total capacity but in the number of installations. No data are available to show the amount of coal actually burned in this form by utilities and industries, but the approximate amount consumed is shown on this chart. It is probable that these figures are too low for the early part of the period, although they are approximately correct for the latter part. Most of the coal used in the cement industry is used in pulverized form, and its curve shows that the amount so used has more than doubled during the period. Quite large tonnages are used in the copper and steel industries, but no data as to the total amount used are available for each year of the period. It is probable that during the year 1929 at least 25 million tons of pulverized coal were burned under boilers and in industry. A new use of coal in this form is in the brick industry, where continuous kilns are just being introduced, but it is probable that these will result in a saving of fuel per unit.

The use of pulverized fuel in marine boilers has been increasing steadily, and this use is one that we believe indicates that the coal industry can recover a large part of the bunker business that it has lost to oil burners. The latest figures available show that there are now afloat 16 vessels using pulverized fuel, some 5 or 6 of these having been designed particularly for this purpose,

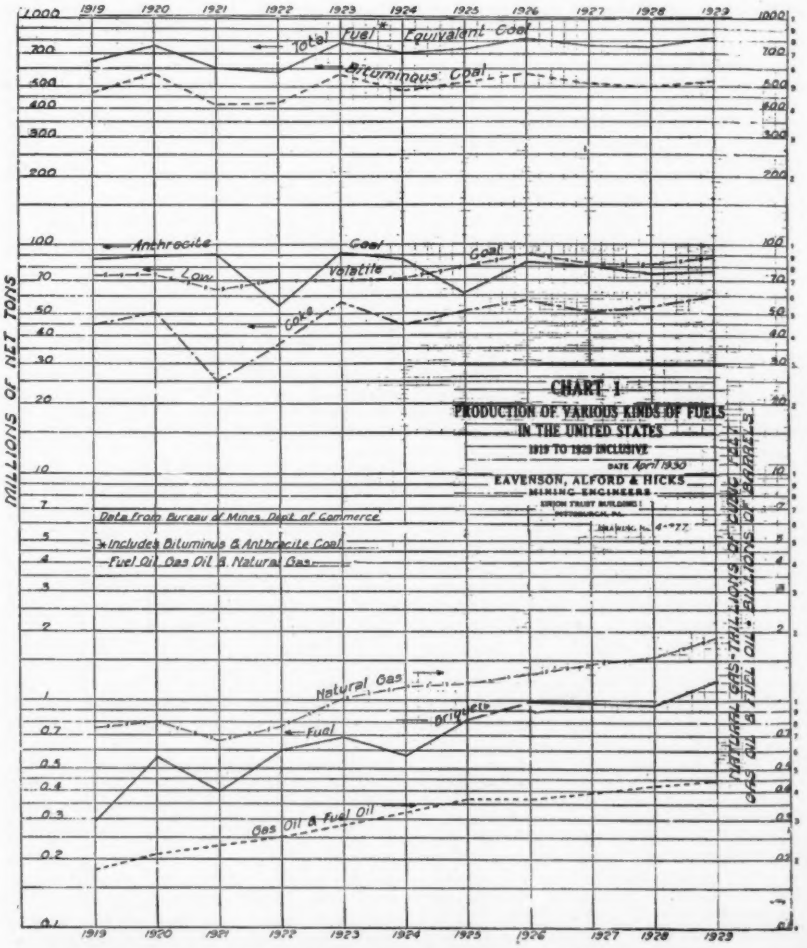

Chart 1—Production of Various Kinds of Fuels in the United States, 1919 to 1929, Inclusive

* Eavenson, Alford & Hicks, Consulting Engineers, Pittsburgh, Pa.

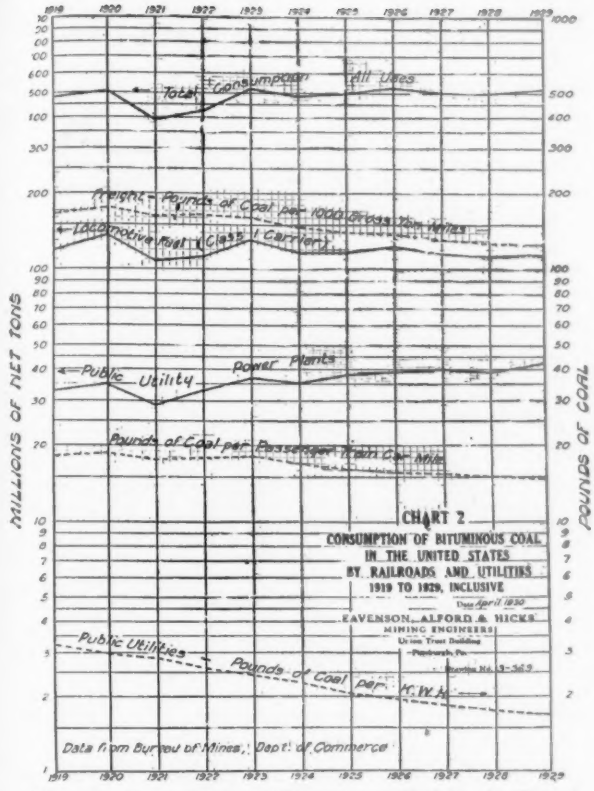
CHART 2
CONSUMPTION OF BITUMINOUS COAL IN THE UNITED STATES BY RAILROADS AND UTILITIES 1919 TO 1929, INCLUSIVE
Date April 1930
RAVENSON, ALFORD & HICKS
MINING ENGINEERS
Union Trust Building
Pittsburgh, Pa.
Drawing No. 3-369
Total Consumption All Uses
Freight - Pounds of Coal per 1000 Gross Ton Miles
Locomotive Fuel Class I Carriers
Public Utility
Power Plants
Pounds of Coal per Passenger Train Car Mile
Public Utilities
Pounds of Coal per K.W.H.
Data from Bureau of Mines, Dep't. of Commerce
MILLIONS OF NET TONS
POUNDS OF COAL

Chart 2—Consumption of Bituminous Coal in the United States by Railroads and Utilities, 1919 to 1929, Inclusive

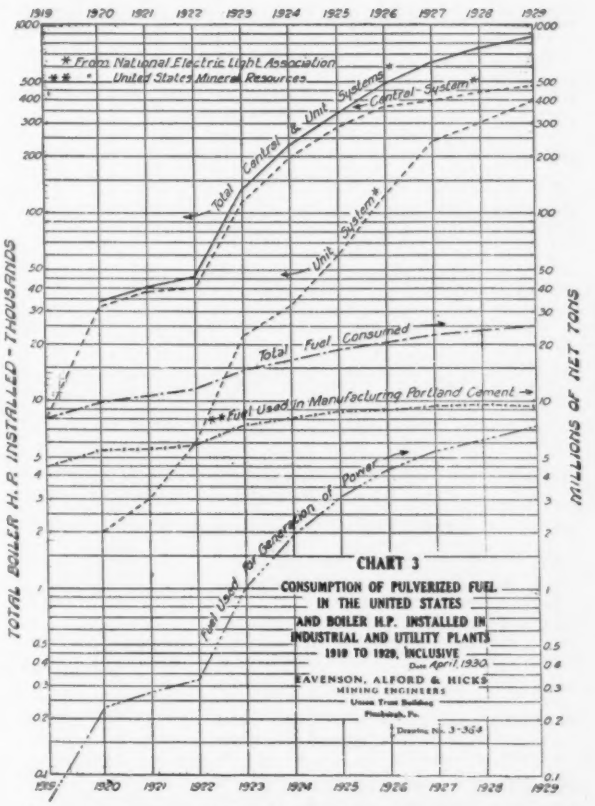
* From National Electric Light Association
** United States Mineral Resources
Total Central & Unit Systems*
Central System*
Unit Systems*
Total Fuel Consumed
**Fuel Used in Manufacturing Portland Cement
Fuel Used for Generation of Power
CHART 3
CONSUMPTION OF PULVERIZED FUEL IN THE UNITED STATES AND BOILER H.P. INSTALLED IN INDUSTRIAL AND UTILITY PLANTS 1919 TO 1929, INCLUSIVE
Date April 1930
RAVENSON, ALFORD & HICKS
MINING ENGINEERS
Union Trust Building
Pittsburgh, Pa.
Drawing No. 3-368
TOTAL BOILER H.P. INSTALLED - THOUSANDS
MILLIONS OF NET TONS

Chart 3—Consumption of Pulverized Fuel in the United States and Boiler Horsepower Installed in Industrial and Utility Plants, 1919 to 1929, Inclusive

while the remainder are converted from other systems of firing. It seems to be true that the experience gained so far has shown that the method is entirely satisfactory, and that for new ships it is much more economical than hand-fired boilers and usually is more economical than oil—the latter condition, however, depending upon the sources of the two fuels available—and that in locations where the steamship travel is the heaviest it is probable that the use of pulverized coal will work out in nearly all cases cheaper than oil. When the long-heralded rapid decrease in the use of oil takes place, it is probable that its successor will be pulverized fuel, but no one can now predict when this event will happen. It is almost certain, however, that the use of coal in steamships has reached its lowest point, and that from now on it will continue to increase.

Chart No. 4 shows the amount of anthracite, coke, briquettes, oil and natural and manufactured gas used for domestic purposes. Bureau of Mines reports say from 56,000,000 to 77,000,000 tons of bituminous coal is used annually for domestic purposes, but no exact data are available. Each of these fuels, excepting anthracite, shows a comparatively steady increase in use. It seems to be true that the use of bituminous coal for domestic purposes has been increasing somewhat.

One of the most interesting tendencies in domestic heating is the trend toward what may be called luxury heating, or where the result desired is obtained by using other than the cheapest fuels. The first sign of this was the use of oil burners and the last one is the increasing use of manufactured gas, and apparently many house owners are beginning to feel

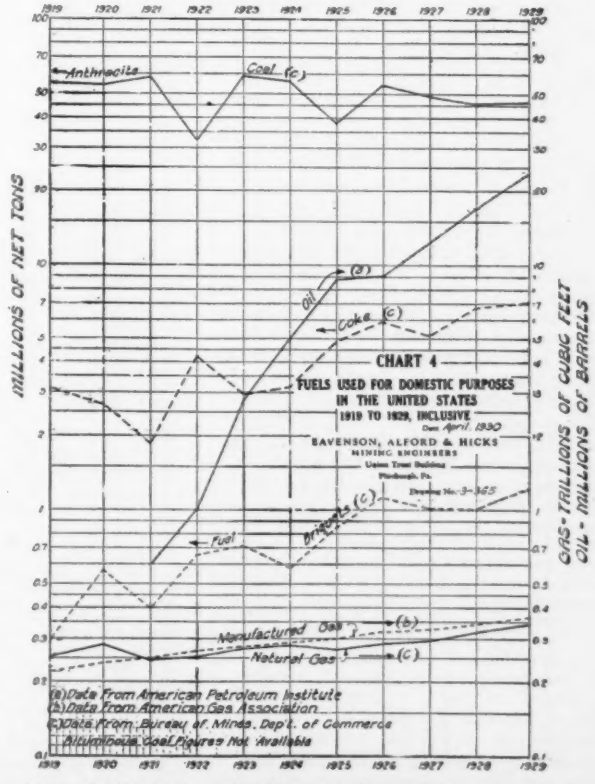
Anthracite
Coal (c)
Oil (a)
Coke (c)
CHART 4
FUELS USED FOR DOMESTIC PURPOSES IN THE UNITED STATES 1919 TO 1929, INCLUSIVE
Date April 1930
RAVENSON, ALFORD & HICKS
MINING ENGINEERS
Union Trust Building
Pittsburgh, Pa.
Drawing No. 3-365
Fuel Briquets (c)
Manufactured Gas (b)
Natural Gas (c)
(a) Data from American Petroleum Institute
(b) Data from American Gas Association
(c) Data from Bureau of Mines, Dep't. of Commerce
Bituminous Coal Figures Not Available
MILLIONS OF NET TONS
GAS - TRILLIONS OF CUBIC FEET
OIL - MILLIONS OF BARRELS

Chart 4—Fuels Used for Domestic Purposes in the United States, 1919 to 1929, Inclusive

TABLE I
CONSUMPTION OF VARIOUS KINDS OF MINERAL FUELS IN THE UNITED STATES
1919 to 1929, INCLUSIVE

	Bituminous Coal (Net Tons) Millions	Anthracite Coal (Net Tons) Millions	Total Coal (Net Tons) Millions	Fuel Oil & Gas Oil Barrels (42 Gallons) Millions	Fuel Oil & Gas Oil Equiv. Coal (Net Tons) Millions	Natural Gas Cubic Feet Billions	Natural Gas Equiv. Coal (Net Tons) Millions	Total Fuels Equiv. Coal (Net Tons) Millions
1919	482	73	555	128	38	746	30	623
1920	509	77	586	167	50	798	32	668
1921	392	73	465	196	59	666	27	551
1922	427	51	478	240	72	763	31	581
1923	519	78	597	261	78	1,007	41	716
1924	484	72	556	292	87	1,141	46	689
1925	499	57	556	356	107	1,188	48	711
1926	533	69	602	341	102	1,313	53	757
1927	500	67	567	345	103	1,445	58	728
1928	499	66	565	388	116	1,568	63	744
1929*	519	67	586	430	129	1,900	77	792

Data from Bureau of Mines, Department of Commerce

* Subject to revision.

TABLE II
DOMESTIC AND COMMERCIAL OIL HEATING

Year*	DOMESTIC: No. of Oil Burners Operating	DOMESTIC: Fuel Oil Consumed Barrels Thousands	DOMESTIC: Equivalent Coal Net Tons Thousands	COMMERCIAL: No. of Oil Burners Operating	COMMERCIAL: Fuel Oil Consumed Barrels Thousands	COMMERCIAL: Equivalent Coal Net Tons Thousands
1921	12,500	600	180	.....	.....	.....
1922	21,500	1,040	311	.....	.....	.....
1923	58,800	2,820	844	.....	.....	.....
1924	101,800	5,020	1,503	.....	.....	.....
1925	181,800	8,830	2,644	24,000	12,000	3,593
1926	169,400	9,080	2,719	27,800	13,875	4,154
1927	221,500	12,380	3,706	30,300	15,145	4,534
1928	304,200	17,000	5,090	33,550	16,750	5,015
1929	422,700	23,538	7,047	.....	.....	.....

Data from American Petroleum Institute.

* Consumption refers to fuel year—1925 figures indicate consumption during winter 1925-1926.

toward their home comfort as they do about cars, washing machines, refrigerators and radios—that they must have it regardless of cost. In Massachusetts alone the number of buildings being heated by gas-fired central heating plants increased from approximately 1,000 on January 1, 1927, to 4,000 on January 1, 1930. This trend is one that the coal industry has practically neglected, mindless of the fact that it offers an opportunity not only to prevent the extension of the use of other fuels, but to recover some of the market already lost.

Table II shows the number of oil burners installed for both domestic and commercial heating, the amount of oil used for each class, and its approximate equivalent in coal. The installation of oil burners is actively pushed by the Oil Heating Institute, American Oil Burner Association, American Petroleum Institute and the National Electric Light Association through its general merchandising committee. The anthracite operators for several years have been testing and developing devices for burning their small sizes in house furnaces, and a number of makes of stokers and similar devices for bituminous coal have been put on the market within the last few years. These will burn slack smokelessly, are cheap and use cheap fuel. No data are available as to the number in use—the only guesses are for a total of 10,000 to 15,000. As against the imposing figures available for oil burners and the organizations pushing them, the coal men can show only a few cases where they are helping in installations and it is only recently that the stoker manufacturers have organized themselves. If the coal industry does not sponsor a movement to push such devices, and possibly an adaptation of pulverized coal to domestic heating, it can only expect to see a further steady increase in the use of oil and of both natural and manufactured gas for house heating.

TABLE III

Class of Building	No.	Tons of Refrigeration Installed	Tons of Refrigeration Probable	Time of Use Months	Approx. kw.-hr. per year	Approx. Coal Used per Year, Tons
Theatres	+ 200	30,000	225,000	6	19,500,000	14,600
Department Stores		6,000	120,000	12	7,800,000	5,900
Public Buildings						
Office Buildings		40,000		3-4	20,000,000	15,000
Industrial Buildings						
Houses			540,000	3-4		

About the only new use of coal within the last few years, and that mainly indirectly through the use of electric motors, has been in air cooling and conditioning.

It has been many centuries since man first began to warm himself by the sun's rays and later by fire, and it has probably been nearly as many since he began to cool himself by seeking the shade or water, but it has only been within the last few years that he began to use artificial cooling methods to make himself comfortable. Is there any more reason why we should suffer from the heat in our hot climates when we can be made comfortable by modern methods, when we continually use them to heat ourselves in cold climates? The only answer is that it has been easier to apply heat by crude methods; but now we can go to a cooled theatre to see a movie, or a vaudeville show, or can buy goods in a cooled department store, and a few of the advanced minded can be thoroughly comfortable at home in cooled rooms. Now that we are becoming luxury minded in our heating methods, is it too much to think that in our hotter climates we will soon begin to cool our homes, and the buildings in which we work, and in doing so encourage the use of electricity and indirectly coal?

Available data about the amount of refrigeration installed are scarce, but the figures in *Table III* are probably conservative.

If the use of cooled and conditioned air in houses can be popularized, no one can tell how great its growth will be.

To summarize the results of this study, we see a gradual trend toward the use of coal in some other than its original state; that the new uses in sight will hardly more than balance the savings being made by more efficient use, if it will do that, and that the industry should do all in its power to encourage the installation and use of more convenient methods of house heating in order to forestall the increasing use of oil and gas for that purpose.

When one searches for data to illustrate a study like this it is amazing to find how little there is available showing the distribution and use of coal in various forms, industries and localities. Some national organization should be provided with funds enough to get statistics of this kind that would show annually the changes in the use and distribution of fuels.

Developments in Strip Mining . . . in the United States

By K. A. Spencer *

STRIP mining is now being carried on in 17 states, the industry produced 4 percent of the total bituminous tonnage in 1929 and as an industry, covers many problems of economic importance as well as individual operating problems. One might spend a great deal of time in discussing finances, general management, sales, or engineering as applied to the strip mining. For example, engineering would include civil engineering in the development and management of properties, mechanical engineering in the selection and maintenance of mechanical equipment, electrical engineering in the supervision of electric mechanisms. It would be interesting to discuss, for a more detailed example, the relative merits of shunt and series wound motors as applied to the modern excavating machine. Industrial engineering is practiced in the time studies and personal supervision of the strip mines. Modern strip mining companies have their own chemical laboratories in which the chemical engineers are making coal analyses and testing strength of material to be used on the property. Any one of these subjects would be an appropriate course for a college student and he could well spend four years in preparing himself upon it.

These questions have confronted me in trying to select from this broad field, what might be of most interest to the gentlemen of this Mining Congress in the few minutes assigned to me. I have looked for published information on this subject and find, with the exception of the good work carried on by the Bureau of Mines and current articles in trade journals, that we must turn to the industry itself for first hand information.

In considering the subject in a broad way, I have naturally compared it with the underground mining of this country and find the economic problems which confront strip mining are also common to the deep mining. The fact that there is an over production of bituminous coal affects both phases of the industry. The fact that combustion engineers have learned to burn coal more efficiently and so reduced the annual consumption of bituminous coal, although our national power requirements are consistently increasing, is shared mutually by the underground and strip mine operators. The fact that substitutes for coal have made marked increase in the past five years is a question that confronts the coal industry at large. The fact that there is too much capital invested in mining properties, that there are too many men employed in the mining industry, all of these facts and scores of others that could be named, are of mutual interest to the coal operators, whether he be a strip or deep mine operator. In fact, as one thinks of the coal industry, he does not think in terms of strip mines or deep mines and we find that the problems are so interwoven and so dependent, one on the other, that it is safe to conclude that in any one year, deep mines can not in general, operate profitably unless the strip mines also prosper and the reverse is just as true. The coal industry has been accused of progressing like that lovable old knight, "Don Quixote, traveling its uncertain way, mistaking peasants for duchesses and fighting windmills until the present moment." Possibly the development of strip mining is an indication that Don Quixote has decided to live a more sober life, possibly coal is being exploited along more economic lines, possibly it is a step away from the traditions and customs as old as the industry itself and I believe these steps are in the right direction, as they tend to relieve some of the distressed conditions that now exist in the industry.

While the stripping industry represents a meager portion of our nation's tonnage, the strip production has increased materially. It is interesting to observe that in 1918 there were 10,648,428 tons of strip coal loaded, as compared with 19,788,577 tons 10 years later. This increase in tonnage has been in excess of the increase of the underground mining methods, due to many reasons. It is possibly due to the fact that the coal can be completely recovered by the open face mining method and so conserves our mineral resources, or it may be due to the adaptability of the method of mining to fluctuate and uncover coal in summer months and have it ready for maximum production through more favorable seasons. The fact that there is less hazard attached to the stripping industry has its advantages and any system that lends itself to 100 percent mechanization is appealing to this mechanized age in which we are now living. The one outstanding reason for the increased tonnage from strip mines is that in comparison with other methods of mining, it has been, in many cases, cheaper to load coal by strip mining and since we are all in the industry for what money we can make, strip mining has increased rapidly.

History of Strip Mining

There are other points of more interest than the history of strip mining, but at this point may I simply summarize the brief history of this industry by saying that the earliest records of open face mining go back to Pennsylvania, where wheelbarrow runs and dumps can yet be observed in the anthracite district. Later, horses with plows and slips and wheel scrapers were used. We find as early as 1866, small team pits open in the Danville district of Illinois and in 1877, J. N. Hodges, former president of the Pittsburg & Midway Coal Mining Company of Pittsburg, Kans., rented a small steam shovel which was invented in 1839 and opened up a small strip pit, using the first power shovel on property owned by his company and the dumps are now still evident within the shadows of the company's present 16 cu. yd. modern electric shovel.

Danville, Ill., has seen stripping carried on from its infancy. From the time of the wooden dredges, mounted on wooden frames and rollers, up to the present modern shovels. Drag lines were used early in the development of strip mining. W. G. Hartshorn and Grant Holmes are pioneers in stripping, and saw early the need of shovels of greater digging power and dumping range. In 1910, the Vulcan Company built small shovels that were used in the Kansas field and so the evolution of machinery and methods progressed slowly until about 1904, and for the 10 years that followed there was rapid development. This was probably due largely to the construction of the Panama Canal, which demanded all of the resourcefulness of the shovel manufacturers and the men in charge of this project to develop an efficient machine.

It is interesting at this point to observe that during this 10-year period from 1904 to 1914, 101 shovels were required to move 130,112,734 cu. yds. of dirt, shale and rock. A large portion of this material had to be hauled away from the excavating unit; however, it would not be impossible for two of the modern large capacity electric shovels to remove this same cubic yardage in the same period. As interesting as is the development of these gigantic strippers, we must pass on to a more current phase of the stripping industry.

General Survey of Strip Mining Conditions in the United States

Some of us who are charged with operating mining properties at a profit and satisfying our stockholders, will have a hard time in imagining the hypothetical situation which I intend to use. Let us assume that a group of bankers called us in their office and told us they had a casual knowledge of strip mining industry and they believe it will be profitable and they would finance a project and deputize us to go out in the United States and search for a set of conditions best adapted for strip mining that would yield the largest dividends.

In casually going over the various fields, we would find that it would be rather easy to group the stripping fields by states, or groups of states. It would probably not be unreasonable, on account of the spectacular performance of strip mining in Illinois, to look there first for our ideal set of conditions and we would find the conditions of Illinois, Indiana and Kentucky are rather uniform and that we may consider the strip mining fields of these three states together. We find in this area that the numbers 2, 3, 4, 5, 6, and 7 veins and the upper and lower Brazil block coal are being strip mined. We would find also that Illinois and Indiana have 48 strip mines which last year produced approximately 10,850,500 tons of bituminous coal. There are mines in these states producing from 3,100 to 931,732 tons during the year. We would observe that the operators of these states are using large and the most modern equipment,

* Charge of Engineering, Pittsburg & Midway Coal Mining Co.

that they have developed the use of drag lines in order to recover coal beyond the depth of a single unit operation, that where the overburden is particularly hard, liquid oxygen is being used to prepare the overburden. We observe, particularly in Illinois and Indiana, topography of the stripping area is typical prairie country and that the seams of coal lie nearly level, although the surface may be eroded into quite an irregular pattern. We would observe in these states that the strip mines have enjoyed good operating time, that the physical conditions, with the exception of limestone which overlies some of the veins, particularly No. 6 and the extreme soft material which overlies the No. 2 vein in northern Illinois, are good. However, upon closer study of the fields in these states, we find there is still a large reserve of strip mine coal available and we may find an answer for this, in the fact that since Illinois is one of the principal coal producing states in the union and that deep mining has reached a very high point of efficiency, that competition between the two methods is very keen and there is not, as in some states, a marked difference in the finished cost of strip mined coal as compared with deep mined coal, and I believe, with the rapid developments made in the mechanization of the modern deep mines in this state, that there will be little difference in the production cost. The strip areas of Illinois are contiguous to one of the largest coal consuming districts in the world, however, due to good physical conditions, both in strip mining and deep mining and with the rapid progress being made in economical operation of both systems of mining, the coal furnished this large industrial area is being furnished at a very low price and this fact must not be overlooked in reporting back to our bankers.

We may leave the producing fields of Illinois, Indiana and Kentucky and investigate the strip coal areas of Pennsylvania, eastern Ohio and West Virginia. Here we find that this district has produced in 1929 approximately 2,949,768 tons of bituminous coal. We find the conditions here are very different from Illinois, the topography is rugged, the coal seams have greater dip, that the principal production comes from No. 8, or Pittsburg seam, which is from 4½ to 7 ft. in thickness, that the overburden is very hard, and that the cost of blasting, preparatory to stripping, in many Pennsylvania mines exceeds the total cost of stripping in the Prairie States, and the overburden varies from 10 ft. to 50 ft. On account of the irregular topography, often the limiting factor is cutting through the hills, and it is necessary to use long booms, smaller dipper capacity shovels to exploit the property. We find that in Virginia the maximum tonnage was reached in 1923, and that in 1929 little, if any, strip coal was produced. If the conditions that our bankers are looking for were right in West Virginia, this would not be true. We find, too, in West Virginia a very competitive market and efficient underground mines and rather undesirable conditions for strip mining.

Going back to the Prairie States, we find intensive strip mining in Kansas, Missouri and Oklahoma. These states in 1929 produced approximately 3,350,361 tons of bituminous coal. In this area the overburden varies from 10 ft. to 45 ft. and four veins are being mined, ranging in thickness from 12 in. to 36 in. The overburden is composed of flat sedimentary shales and rock, which stack well and is termed by the shovel companies easy, fast digging. If this fact were not true concerning the overburden, it would be unprofitable to remove 16 to 18 cu. yd. of overburden for 1 ton of coal, as is the practice in the Kansas field. We find the operators of Kansas realize the necessity of removing the overburden cheaply per yard and, while the tonnage from the states do not imply large yardage, the production records of stripping shovels in Kansas and Missouri are very satisfactory. The Kansas coal field lies on the edge of one of the largest oil-producing areas in the world. We find that industrial contracts for natural gas are being let as low as 8½ cents per 1,000 cu. ft. However, the strip mines of the area produce approximately 60 percent of the entire bituminous tonnage, because the deep mines have never been fully mechanized and there is a marked differential of mining costs between the deep and strip mines of this area. Upon further investigation, we find that the stripping area is confined and that the available acreage is largely in the hands of operating companies. The area is only approximately 60 miles long and there is a thin band of strip coal along the outcrop of the four seams mentioned previously, running approximately parallel in a northeasterly-southwesterly direction, and these seams have been well-defined by previous drilling for deep mine coal in the area, year previous.

In hunting an area where there is an abundance of undeveloped coal, after leaving the Kansas field, we might investigate the two lignite states—North Dakota and Texas. Here we find lignite deposits which vary in thickness in North Dakota from 8 ft. to 18 ft., with 20 ft. to 25 ft. of overburden. There was approximately 900,000 tons of this coal produced in 1929, while in Texas two plants produced 320,000 tons of coal on a vein from 8 ft. to 13 ft. in thickness. In both of these states, however, market is the principal consideration. In North Dakota, on account of its sparse population and the distance from highly developed industrial centers, and with the exception of railway fuel, there is little demand for large tonnage from this area. Texas, like Kansas, is surrounded with cheap oil and gas. Newly developed oil wells in this area are producing 100,000 barrels per day, or an equivalent of 26,315 tons of high-grade bituminous coal. This production is transported east to Pennsylvania by pipe lines—that is competition. The coal itself is not as high in quality as eastern coals, and this fact reduces its shipping radius. It must be burned in a country that requires little fuel.

Many of the conditions which prevail in North Dakota and Texas are true in Wyoming and Montana. These two states produced approximately 1,572,500 tons in 1929. The coal is of a hard sub-bituminous grade, and in Montana is about 22 ft. thick. A single plant in this state has a strip reserve of 43,000,000 tons under 40 ft. of overburden. This coal is consumed largely by the North Pacific Railway and is delivered to them at a price that would stagger many operators. To my knowledge, the 79-ft. seam of sub-bituminous coal in Wyoming is the thickest seam now being mined in this country. It is at this mine, near Gillette, that the overburden is being removed by the hydraulic method and the coal is collected at the bottom of the face, after being shot down and conveyed directly into the tipple. The soft overburden above this mammoth vein of coal is 17 ft. to 25 ft., and there is a tremendous reserve along railways in this state that could be very cheaply mined if market was available.

Arkansas has conditions peculiar to itself and 98,000 tons of strip mined coal was produced in this state, the seam being 15 in. thick and overlain with hard black slate and blue shale. All of the overburden has to be blasted and the ratio is about 22 yds. of overburden to 1 ton of coal. However, this semi-anthracite coal realizes a splendid market price, and this fact alone accounts for any strip mining being carried on in the state. Due to the physical conditions, the costs of strip mining in Arkansas are very close to deep mine costs, and, too, there is a very restricted area in which strip mining can be carried on. Many seams in Arkansas have been tilted and distorted by the Ozark uplift until they have become unpractical to mine by strip mining.

We may also observe a small tonnage of strip coal being produced in Georgia and Alabama. Here, however, as in Arkansas, the tonnage is small and conditions are unfavorable. The topography is irregular and the stripping areas are restricted. The coal being mined in Georgia is 42 in. thick and the hard overburden varies from 10 ft. to 35 ft., while in Alabama 15 ft. to 40 ft. of overburden is removed to recover 4½ to 8 ft. veins of coal. Coal from these veins is washed to remove the impurities found in the partings in the coal. One mine in Alabama is operating on a 24-in. seam of clean coal with a ratio of 12 cu. yds. of overburden to 1 ton of coal. The operations in these states have not warranted the installation of large equipment and the competition is keen with the well-developed larger slope mines.

This would complete a hurried survey of the strip mine districts of the United States, and we would observe in summarizing that in 17 states there were approximately 20,748,342 tons of bituminous coal mined in 1929. Details by states are listed in the table below:

TONNAGE OF BITUMINOUS COAL LOADED IN THE UNITED STATES—1928-1929

	1928	1929
1. Alabama	333,186	§300,000
2. Arkansas	107,164	§98,000
3. Georgia	58,390	§40,000
4. Illinois	4,339,442	5,550,493
5. Indiana	4,823,012	§5,300,000
6. Kansas	1,206,420	1,046,768
7. Kentucky	701,619	281,472
8. Missouri	1,778,507	1,886,341
9. Montana	1,181,004	1,500,000
10. North Dakota	756,131	§900,000
11. Ohio	2,373,704	†1,749,768
12. Oklahoma	516,522	417,752
13. Pennsylvania*	1,076,871	§1,200,000
14. Tennessee	85,428	§85,000
15. Texas	330,599	§320,000
16. West Virginia	48,809	None
17. Wyoming	71,769	‡72,748
	19,788,577	20,748,342

* Pennsylvania loaded 2,163,325 tons of anthracite in addition, 1928.
† Not complete.
‡ One mine, northwestern Wyoming.
§ Approximately.

In the report to our bankers, we would make the following remarks: That equally able men are in charge of the

operations at the various mines throughout the United States and the tonnage represented by districts is an index to the conditions, both physical and economic, which surround the various groups of states. Probably the largest single factor which controls the production of strip mined coal is market opportunities. It would be a problem to select an area where all of the conditions were most desirable and our duty would be to choose from the various conditions, that set of conditions which incorporates the greatest number of advantages, in order that we might avoid the responsibility of making a final decision, the problem should be put to the sales managers and not to the operating department for final answer, as I believe strip mines in this country should be opened up only after the market has been thoroughly analyzed and there has been definite assurance that the tonnage can be sold at a price that will assure a reasonable return on investment, before a single yard of overburden is removed. However, if suitable market is assured, we must investigate various methods of mining and we find that methods vary with the physical conditions of the property. Methods applicable to the prairie of Illinois and Kansas, do not pertain to Pennsylvania and Arkansas. In Illinois, where overburden is deep and banks do not stand well under all weather conditions, it is necessary to carry a wide burm and the haulage tracks are always on the coal. It is common practice to haul the coal under the stripping unit.

Standard type loaders are used, because there is little demand to load larger sized lump, while in Kansas, horizontal type loaders are used in order to make the minimum amount of fine coal. Tracks can be carried on the surface and the coal hoisted by skips to cars on top, this eliminates the burm in the pit and so reduces the angle of the swing of the stripping shovel and increased yardage essential to mines where high ratio of yardage to coal pertain. Where high seams are being mined, loading is given more consideration and the stripping unit is penalized in favor of the loading units and too, the rough topography would not permit the laying of the tracks on the surface. In Illinois and Indiana, it has been found profitable to go deeper for the vein of coal than in stripping areas where the coal seams are thinner, this has brought about the use of drag lines ahead of the stripping shovel, or in one case the development of extremely long boom and long dipper stick, the long range shovel. In some fields, where the overburden is harder, operators have developed the use of liquid oxygen to prepare the overburden and shovels with smaller bucket capacity are used, while in Kansas, in the easy, fast digging, shovels with short front and combinations have been developed.

An example is the 750-B shovel with the 78-ft. boom, 58-ft. sticks and 16-yd., water measure bucket. This is a proper tool where high ratios are to be handled on thin veins of coal with overburden not to exceed 40 ft. The most unique method of removing overburden is the hydraulic method in Wyoming, where the hydraulic monitor with a stream of water under 65 pounds of pressure is used in washing down to the sump, the overburden above the coal. Here, the material in solution is forced by a centrifugal pump through 8-in. pipe to a discharge several hundred feet from the open pit. All of these methods use machinery in one manner or another and after the method has been decided upon, it is necessary to make the choice in machinery.

Development of Strip Mining Machinery

The machinery may be considered in the order it is to be used in the development of the mining property. We will find first, that the prospect drills used are of the churn type. Very few strip mine properties have been drilled out with core drills. The coal seams are relatively close to the surface and accurate information can be obtained through these shallow holes with a churn type drill. Many strip mine properties in the areas where the overlying formations are soft have been prospected by hand augers. This is particularly true in northern Illinois, Kansas, and Oklahoma. In the areas where topography is irregular, outcrops are common and it is a problem of determining maximum depths around and through hills which are to be removed, while in areas where the rocks lay nearly horizontal, it is a matter of locating soft or inferior areas of coal. In Kansas it is not uncommon to be able to predict, within 6 in. of where coal will be encountered in the drill hole, after surface elevation has been determined. The remarkable thing of the geology of the Kansas and Oklahoma fields, is its uniformity and its consistent regional dip away from the Ozark uplift. Operating companies have found that the geologists' plane table and aneroid barometer facilitate materially, the field work of the engineers who chart the prospecting work. Since surface drainage is of major importance in open pit mining, the surface is usually contoured at the same time drilling is being carried on. In prairie country, it is not uncommon to contour the surface on 1 ft. contour intervals and after drilling has been completed, structure maps of the coal on the same interval are prepared. These two maps are indispensable in making plans for the surface and pit drainage. It is also often the practice to plot on the maps, areas by ratios of cubic yards of overburden to one ton of coal, rather than the maximum depths and I believe, in most of the modern strip mines, the pits for at least a year in advance are extended on the maps before they are excavated. The manufacturers of drills have, in recent years, developed drills suitable for bank shooting for open faced mining. These high capacity drills, drilling holes from 3½ in to 8 in. in diameter, have materially facilitated the problems of preparing the bank for excavation. The larger diameter holes permit proper loading of the holes and I think this fact alone, along with the development of liquid oxygen, have made some veins of coal which are overlain with hard sandstone and limestone available to strip mining, that would otherwise be impractical to exploit. I have heard Illinois and Indiana operators who are using liquid oxygen, make the statement that their properties could not have been operated profitably without the use of liquid oxygen in this day of competitive prices.

The power shovel or excavating unit, is the most spectacular unit in a strip mine, on account of its bulk weight and tremendous size. These shovels have grown from the little wooden machines used in the early days of Mr. Holmes and Mr. Hodges, through the development of 1½ to 3½-yd. shovels, which cost approximately $10,000. Through the trying years of 1900 to 1910, when the basic principals of modern shovel designs have been well established and by 1911 the 3½-yd. shovel had become standard with a 65-ft. boom, weighing approximately 273,000 pounds, which sold for about .08 cents per pound. The development from this date was rapid and soon came the 6-yd. bucket. It was about this time that the practical application of electricity to the stripping unit was developed. These shovels were far superior to steam shovels then available. The development of the Ward-Leonard control on the direct current shovels was a decided step ahead of the old contactor control on the a. c. machine and, bringing development of these modern shovels up to date, we find that at the Fidelity mine of the United Electric Company at DuQuoin, the Marion Steam Shovel Company have recently installed a 5,600 unit, which is equipped with 120-ft. boom, 15-cu. yd. dipper, which has an approximate working weight of 3,300,000 pounds. The Bucyrus-Erie Company have in operation, a shovel in the Pittsburg field with a 75-ft. boom and 16-cu. yd. bucket, which has a gross working weight of 1,008 tons.

The Marion Steam Shovel Company and the Bucyrus-Erie Company have at present, the following shovels employed in the coal industry:

	Electric	Steam	Total
6 cu. yd. and over.....	88	163	251
Less than 6 cu. yd.....	92	305	397
Total	180	468	648

Summarizing these figures, we find there are 180 electric shovels, 468 steam shovels or a total of 648 shovels of both types, now in use in the coal industry in the United States. These shovels alone represent an investment of approximately $50,000,000.

The big modern electric shovels are very efficient mechanical units. I am familiar with the record of one shovel which, for the past four months, has operated 92 percent efficient. One hundred percent efficiency in this case meaning the shovel is in continuous operation all of the time available of the working shifts. The shovel has been on three eight-hour shifts, six days per week, Sunday the shovel does not work as a matter of policy with the company. In other words, 92 percent of the time the crew is on the shovel with instructions to dig, the machine is in motion and removing overburden. The records of this same company indicate that the best efficiency obtained from steam shovels was approximately 69 percent. These delays were caused by more numerous breakdowns, cleaning of fires, taking on board coal, changing water lines and other miscellaneous delays incidental to the operation of steam machinery.

A prominent Indiana operator has made the statement that 1929 has definitely proven that steam shovels are obsolete.

The development of caterpillars which probably owes its rapid growth to the intensive use of caterpillars during the war, have been a marked improvement

on the modern shovels. I believe at least 5 percent of the increased efficiency of the modern shovel has been obtained by the use of caterpillars or crawling traction trucks. Large type drag lines have been developed simultaneously with the large shovels and it has only been in recent years that a practical system of mining has been worked out, whereby both the shovel and the drag line are on the coal. This dragline, shovel combination, and the larger type shovels have made available for the strip mines, millions of tons of coal that would have otherwise been impractical to mine. It is remarkable, with these new electric units, the change in attitude regarding breakdowns. A few years ago shovels were expected to break down continuously and their breakdowns were accepted as being inherent in stripping work. Today, shovels are not expected to break down and a breakdown on one of the large electric units is a matter of serious importance and is usually brought to the attention of the general superintendant within a few minutes after its occurrence. The increased efficiency has been largely due to more continuous operation made possible by the heavier type electric machines.

I am familiar with a shovel in the Kansas field which, in the month of October, 1929, moved 456,170 cu. yds., bank measure, in eighty 8-hour shifts and advanced 5,590 ft. in a pit 71 ft. wide and varying from 25 ft. to 41 ft. of overburden, of which 48 percent was so hard it required bank shooting before removing. This gives some idea of the tremendous amount of work which can be accomplished with the modern shovels, and I understand the large type 5,400 at DuQuoin is expected to move, after operating conditions have become normal, one-half million yards per month. There are probably records of bigger yardage than these which have not been brought to my attention.

Less spectacular than the stripping units themselves, but none the less important are the machines used in cleaning the coal preparatory to loading.

The Cherokee seam of coal in the Kansas field contains horse backs or clay slips that are irregular and run without pattern. Approximately 13 percent of the coal in place is composed of horse backs, and it has been found that it materially facilitates loading to remove these horse backs ahead of the loading unit. This is done by a very small ⅜, standard type, ¾, or full revolving shovel. The material in the horse back is dug out, placed in trucks, and is disposed of, or the material is simply stacked out on top of the coal and pushed into the gob with caterpillar tractor propelling maintainer blade. After the coal has been cleaned by the blade it is common practice in many pits to sweep the coal with a power steel brush very similar to the city street sweeper.

I believe the tendency to sell coal on a heat unit basis has accounted more than any one factor for these developments, and I believe these coal-cleaning machines have reduced the free ash in mine-run coal from 2 to 6 percent.

It is standard practice to load the coal with either a standard type shovel or horizontal thrust type. The horizontal type loader is peculiar to the Kansas field, while the standard type of 1½ yd. to 3½ yd. capacity is the common practice in other fields. At one plant in the Kansas field they are using 3¾-yd. bucket of the horizontal type. This machine has distinct advantages in loading thin seams of coal and producing the maximum amount of coarse coal.

I believe some of the operators in Illinois and Indiana, who are operating the thinner seams, would find this Kansas development intensely interesting.

In considering transportation at the modern strip mine, we find today, probably the most talked of subject is the use of standard or narrow gauge tracks. There has been in recent years a marked trend towards the large type, 8-wheeled, standard gauge, self-clearing cars of either the side-dump or drop-bottom type; the more recent installations have included this type of equipment. However, this fact does not prove that the larger cars are altogether the most satisfactory.

A well-posted and efficient Indiana operator has pointed out that on account of the increased cost of maintaining better tracks necessary for the heavier standard gauge cars that it is cheaper per ton to use narrow-gauge track, one-third more trains, and reduce the maintenance cost of the track. This operator has comparative costs on the two gauges of tracks, operating the same make of car of different capacity, and is certainly a comparison worthy of careful consideration. I have had some experience, however, with 42-in. track gauge, 15-ton drop-bottom, 8-wheeled cars, the track being in the pit, and the second plant with standard gauge 35-ton, 8-wheeled, drop-bottom cars with the track on the surface, the coal being loaded from the pit into the car with a skip or bank machine, and our experience indicates the most decided advantage in favor of the larger cars and standard gauge track. This advantage is probably peculiar to our track conditions and represent the other extreme.

Where the loading is concentrated at one point, as in strip mining, it is vital to the tonnage of the mine that adequate transportation facilities be provided. The development of transportation system is often the predominating factor in location of tipple site and manner in which the property is to be opened up. At large mines, where from 2,000 to 4,000 tons of coal are moving out daily over a single main line haulage way, it is imperative that train schedules are not interrupted by work trains in handling supplies for the pit or reject from washery or picking tables at the tipple. It is ordinarily more economical to provide adequate rock disposal than to burden the already overtaxed main line haulage way.

In the strip mines of the country we find conventional type steam locomotives most common, although some Illinois and Indiana operators are using geared locomotives for heavier grades and long trains. Gasoline locomotives have been proven practical in the Kansas field and at one mine, where gasoline locomotives were recently installed, the matter of gross weight of locomotive in relation to its draw-bar pull is the principal consideration. Gasoline electric locomotives have been proven very satisfactory for industrial haulage at strip mines, but, on account of their high first cost, they are not in general use. There has been a tendency in the past year to adapt railroad methods in the industrial tracks of strip mines. I am familiar with strip mines that have semaphore systems and trains are controlled by central dispatching station and the construction of track is as near railroad standards as conditions will permit. This development in better industrial tracks is reflected in reduced transportation costs.

A new development in transportation has recently come about in the Kansas-Missouri field. Here we find two mines loading from 1,500 to 2,000 tons per day which are equipped with large capacity motor trucks. One mine is using a 10-wheeled type truck hauling a maximum load up to 12 tons. These trucks run on definite schedules and have been working very satisfactorily. The advantage of this method of transportation is peculiar to the thin seams of coal where the track cost per ton is high, in the event industrial or standard gauge is used, where the track must be laid in the pit and moved often on account of the thin seam uncovered. The experience with these trucks has indicated that in mines under 2,000 tons that truck haulage is practical in comparison with other types of transportation.

Preparation of Coal

It was natural that when strip mine operators started to build preparation plants that they copied very closely the tipples of the deep mines with which they were familiar. However, closer study has proven that tipples suitable for preparing strip mine coal must include some features not commonly found in the deep-mine screening plants. This fact is true on account of the lack of uniformity in strip mine coal. The problems of designing the modern strip tipple are further complicated by the fact that the coal may be wet or dry, depending upon weather conditions. It is also particularly important that adequate cleaning and screening facilities be provided on account of the big equipment now being used in loading strip mined coal. The larger type equipment makes it impossible to adequately clean the coal at the coal face. Strip operators have developed the use of large capacity hoppers, using automatic drop bottom or side dump cars. This development permits cars to be hauled over the hopper in larger trips. We are now dumping coal at the rate of 120 tons in 35 to 40 seconds from 35-ton, drop-bottom cars into an 180-ton hopper. The conventional means of removing the coal from the hopper is with a reciprocating, variable speed feeder which permits a continuous stream of coal into the tipple, regardless of the tonnage in the hopper. This provides steady running time in the tipple regardless of the days' total tonnage.

After the coal has been conveyed into the tippel and to the head of the shaker screens, there are enumerable methods of preparation with which you are all more or less familiar.

Probably the best example in the modern strip mine tipple is the new tipple recently completed at the United Electric Company's Fidelity mine at DuQuoin, Ill. This tipple covers over 19,000 sq. ft. of ground surface and serves seven railroad tracks and has a rated capacity of 800 tons of coal per hour. The tipple is equipped with adequate crushing facilities and mixing conveyors, so that mixtures of any grade can be readily made, and vibratory screens are provided for the treatment of fine coal. These large modern tipples express a desire by the operators to honestly merchandise their coal by preparing a better product and a size most desirable to the use of the customer.

Washeries at strip mines have been confined to very few installations. Mr. Sherwood, of the Central Indiana Coal Company and Sherwood-Templeton Coal Company, has probably had more experience than any other strip operator in this connection. Mr. Sherwood's comment in relation to washeries at strip mines is "that the result to be had from the use of washery in strip mines are tricky and very much bound up with one's market conditions, possibly more so than with the operating conditions," and I think, with this word concerning washery from a gentleman who has been successful in the operation of washeries, is to be heeded by strip operators contemplating the installation of washeries at this time.

These remarks would not apply to conditions where it was necessary to wash coal to make it suitable for metallurgical purposes, or in cases where the washing of coal is a necessity to make the screenings a merchantable product. These remarks covering development in strip mining machinery cover the subject in a very inadequate and general manner; howover, our time is limited, and we must pass on.

Considering only one other thought, and that is concerning future development for machinery which would be applicable to the industry, and I have in mind the development of machinery that will eliminate cycles from the strip mining industry. I make this remark knowing that before me are representatives of the Bucyrus-Erie and Marion Steam Shovel Companies, who have done probably more than any two other organizations to actually bring to the high stand of efficiency that our stripping equipment is today. However, I am wondering if, where overburden is relatively soft, that a continuous conveyor type machine, similar to those now being used in Germany, would not be a practical method of removing this overburden. With our modern shovels we assume that the unit is only making money when it is actually moving dirt from the highwall, and our time studies indicate that only 21 percent of the entire cycle is occupied in digging, the remaining 79 percent is occupied in swinging, transporting and disposing of the material. If the efficiency of our machine was to be based on these time studies instead of on actual time in operation, the records of our mechanical efficiency would be very poor.

The same thought might be carried into the loading of strip mine coal, and I am wondering if some day there will not be a loading machine developed which will operate continuously rather than by intermittent cycles.

It has been suggested further that the collection of coal in the pit be carried on by portable conveyor systems. This thought concerning the strip operation without cycles is simply left with you for your consideration.

In summarizing the general problems which confront stripping in the United States, I think probably the most important problem is the installation of new mines in territories which are now over equipped and are producing coal in excess of the requirements of the trade territory which it serves. The result of this condition is that large strip mines are installed at a tremendous investment, and after this investment has been made one of two things must result—either the plant be operated part time, which is very expensive on account of the high ratio of fixed charges to variable charges, or the coal is sacrificed at unreasonable prices.

Another thought along this same line is the recent trend toward installation of very large stripping units. We sometimes neglect the fact that our 8 to 12 yd. electric machines are highly efficient machines and will move dirt within 5 percent as cheaply per yard as the largest type modern shovels. However, we are anxious to increase our tonnage, and on the basis that, with the same pay roll, we will increase tonnage, the big shovels are purchased, and then we find that our sales ability can not fluctuate as rapidly as the new loading facilities, and that the larger units must stand by unused a portion of the year.

The result is that properties that could be worked at a profit two years ago are now being abandoned, because they can not compete with the large type units and, as a result, these resources are being wasted.

I think, if the law of supply and demand has ever worked, it is certainly functioning today in the coal-mining industry.

A second general problem confronting our stripping industry is the higher development of the personnel, which is directing the working forces of our strip mines. This includes the supervision of mechanical equipment.

In our race to keep abreast of the modern trends of strip mining and to equip our plants with the latest development of modern equipment, the personal element has been neglected, and, as a prominent strip mine operator has said, "that much can be learned from a year's time devoted to time studies and analysis of our processes at the mine in an attempt to eliminate lost motion and to create and intensify the spirit of cooperation between management and men." I think some strip operators have made definite progress along these lines, but there is much chance for improvement and this point should receive every consideration.

In concluding these remarks, may I leave this thought, that the stripping industry in the past few years is gradually being reduced to an exact science? A few years past it was common belief that, if the shovel was big enough, money could be made from strip mining; but in these competitive days every bit of technical information available is necessary in the solution of problems which confront the stripping industry, and, although power shovels have been employed for over 53 years, it has been in the past three to five years that the industry has acquired its majority and is no longer the favored child of a great industry which has been protected by every economic advantage, but is today a virile, strong, energetic, young man, ready to go along and play its full part in the development of one of the greatest industries of our Nation.

Outstanding Developments in Anthracite (*Continued from page* 19)

This company has experimented with undercutting machines of several types. Recently there has been installed a machine which is 14 ins. high in overall dimensions—this is in a bed from 18 to 24 ins. in thickness. Standard machines previously used are 18 and 22 ins. high. The performance of the 14-in. machine has proven that where good roof conditions prevail, a bed of coal which is 20 ins. thick can be successfully and economically mined; where bad roof conditions are encountered, it was found that a bed of this thickness cannot be economically mined. I have with me some cost figures of this interesting thin bed mining if any of the engineers present would like to consider the same.

In assembling data for this paper to comply with the request of the Mining Congress, I have communicated with the heads of all of the major operating companies, and in addition to what I have before stated from their responses, would close my paper by the following summary.

The practice of driving rock tunnels beneath the floor of thick beds of coal for the purpose of winning coal from such beds through rock holes, instead of from openings in the bed proper, which has been followed for several years in the southern anthracite field, has within the past two or three years been extended to the flat mining in the northern anthracite field. This, however, has not proceeded far enough to say that it is a success.

The use of treated timber is gradually making headway in the maintenance of long life mine openings.

The use of heavier rail in the construction of mine tracks is being adopted by many companies.

Continued progress has been made in the introduction of electrical apparatus instead of steam. This is noticeable where steam boilers are reaching the age limit.

Animal transportation is rapidly disappearing.

Steam reciprocating mine pumps are gradually being replaced by modern electrically operated centrifugal pumps, automatic in operation. In this respect there has also been a tendency to increase the r. p. m. and feet per stage of all types of pumps, so that at the present time an r. p. m. of 1,750 and heads of 250 ft. per stage are quite common.

The miners' oil lamp and the carbide lamp are rapidly being replaced by the electric storage battery cap lamp at many of the anthracite collieries.

Blasting of coal is more and more being done in non-gaseous workings by the use of electric batteries.

Finally, in closing, I feel that this paper is of a somewhat dis-jointed character, but I could only touch upon the highlights in the limited time at my disposal.

The problems of the anthracite producer are being attacked with intelligence, energy and perseverance, and I am convinced that, with the great improvement in the quality of the product as it reaches the market, anthracite will regain its long recognized position as the "Premier Fuel" for domestic purposes. The great virtue of this fuel is that it is "smokeless," "odorless" and "dustless."

Mining Machinery Abroad

By W. H. Rastall *

THE importance of coal in the export trade of England has long been a classic to illustrate the forces that influence international trade. England would starve in a very few weeks without imported food, a substantial percentage of which comes from Argentina, and this would be very much of a one-way trade were it not for the fact that the latter country needs to import fuel. Exported coal, even at nominal freight rates, has exerted a powerful influence in decreasing the costs of importing wheat, beef, and the like, and these coal shipments have at times made it exceedingly difficult for Americans to compete in Argentine trade, the freight rates from England being far more attractive. More recently the British coal trade has been in distress. These shipments are relatively less important than formerly, suggesting that the disturbance to the coal trade has definitely unbalanced the whole economic situation, a balance so delicate that it may often be disturbed before we realize it.

Machinery is also recognized as a factor that exerts most powerful influences on the economic situation. The whole story of the industrial revolution is an epic based on this theme, yet perhaps we think too often of the industrial revolution as the group of incidents that took place in England during certain decades a century and a half ago. Instead it would be far more accurate to consider that the industrial revolution is still with us, for although it has been spreading its influence for a century and a half it is only in recent years that it has spread to cover the entire world, and even now has not reached it full fruition in any progressive country, not to mention those which are usually considered relatively backward. The industrial revolution is today releasing economic forces of the greatest significance in many countries, although in all probability we too often fail to realize the full import of these developments. Asia has absorbed a billion dollars worth of strictly industrial machinery since the Armistice, and it is interesting to speculate upon the consequences that will flow from the employment of this huge volume of equipment among those teeming populations during the next few years. Similarly, Latin America has absorbed $750,000,000 worth of machinery since the war, and although conditions there are very different from those that apply in Asia, it may still be said that the employment of this equipment will lead to the most interesting consequences among our neighbors to the south.

Comparatively speaking, the applications of machinery to mining have come in relatively recent years, and in greater degree in American circles than elsewhere. In certain foreign countries mining methods are still decidedly primitive, but during the last few years some significant developments have taken place, as will be suggested by certain figures that have become available. In the coal industry of Great Britain, for instance, only 8½ percent of the total production was cut by machinery in 1913, a ratio that by 1929 had increased to 27.9 percent—figures which are not representative of certain areas, however. The districts in England that compete most actively with West Virginia and Pennsylvania coals are to be found in South Wales and the northeast counties of England. In Northumberland in 1913 about 13.8 percent of the coal was cut by machine, but this had increased to 55.7 percent by 1929.

In Germany in 1914 only one-half of 1 percent of the coal was mined mechanically, but by 1926 this had increased to 50.4 percent; in the Ruhr, a mining territory that has received a great deal of publicity because of certain political incidents, in 1913 there were only 378 pneumatic percussion picks, 26 large coal-cutting machines, and 231 bar-type coal cutters, which, by the end of 1925, had increased to 71,332 pneumatic picks, 1,044 large coal-cutting machines, 748 bar-type machines, and 316 cutters of a type not used in 1913. In 1926 56 percent of the coal produced in Scotland was mechanically mined; in Belgium, 73.8 percent; in German lower Silesia, 76.3 percent; in the Ruhr, where something like 80 percent of German coal is produced, 65.3 percent; in German upper Silesia, 54.1 percent; figures suggesting that enormous changes are taking place in the coal-producing methods employed abroad.

Similar forces are at work in France, where about 64 percent of the total French production comes from the fields in the Nord and Pas-de-Calais. In the latter district the number of mechanical picks increased from 1,392 in 1913 to 18,320 in 1927, and 65 percent of the product was mechanically mined as contrasted with 4.7 percent in 1913.

More recently Russia has developed keen interest in coal-mining equipment, and during the years 1926, 1927, and 1928 imported nearly three-quarters of a million dollars worth of American coal cutters. It is understood that there are now about 600 of these machines in the Donetz Basin.

Last year American coal cutters were exported to 16 foreign countries in every section of the world, even Australia, New Zealand, Chile and Japan being represented. The employment of all this machinery will necessarily strengthen the cost position of the larger mining companies, and those properties that are adapted to machine mining, and will place at a disadvantage those properties where the character of the seams and the geological formation are not adapted to mechanized operations.

You are all familiar with the more recent developments in underground loading in the United States, and the fact that these operations are in some respects even more complicated than the problems associated with mechanical cutting, but here again we have a class of equipment that is invisibly changing the operating conditions in many mines, placing certain properties at a disadvantage and influencing labor problems as well as production and merchandising problems. Foreign miners are taking more and more interest in this underground loading equipment and, as time passes, where conditions justify, we might expect to see a very large expansion in such applications.

In connection with all this, we should think not only of the equipment shipped from the United States, for Great Britain, in 1928, exported about $425,000 worth of coal cutters, in addition to a huge volume of other mining equipment, and Germany, in the same year, exported about $400,000 worth of mining machinery. In fact, if we consider mining machinery as a whole, rather than just coal equipment, it is interesting to observe that American exports have expanded with startling rapidity in recent years from $6,500,000 in 1922 to nearly $18,000,000 in 1929, this equipment going in the main to 26 foreign countries on every continent.

On the technical side little is to be gained if we look for new types of equipment in these other countries. Generally speaking, the United States furnishes an overwhelming percentage of the coal cutting and other mining machinery absorbed on the world's markets, and the types of equipment used in these foreign countries are, generally speaking, of the same general sort that has been developed for domestic purposes. Furthermore, foreign manufacturers are frequently disposed to copy American designs and it will generally be found that on the technical side American machinery and American mining methods lead the world.

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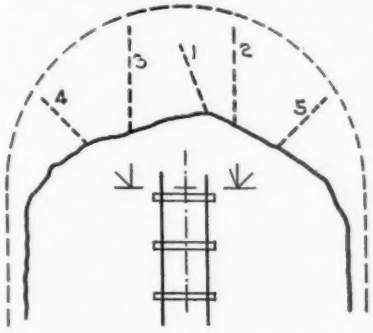
* Chief, Industrial Machinery Division, Bureau Foreign and Domestic Commerce, Department of Commerce.

Coal Cutting and Face Preparation with TRACK MACHINES

By George F. Campbell *

ABOUT 30 years ago the use of electricity found its way into the mines of southern Illinois, and three or four years later the electric driven chain breast undercutting machine put in its appearance to supersede the old air-driven puncher and to hold undisputed supremacy until about 1915. At that time the shortwall machine made a bid for popularity based on its greater cutting capacity, when once unloaded and shifted into working position. Although the puncher has long since entirely disappeared and occupies a place only in history, the breast machines and shortwalls by the hundreds are still working. They have survived up to the present day by sheer merit; the breast machine, perhaps, by reluctance to discard a one time faithful servant for the more powerful and more efficient shortwall, but relegating it to the easier tasks or to stand-by service, while the intensive mining, hard cutting and, in general, the brunt of the job has been done faithfully and well by the shortwall undercutter.



FOR HAND LOADING.
1 SNUBBER, 4 TOP HOLES FROM TWO POST SETTINGS.
SNUBBER DRILLED SUMPING TO END JUST ABOVE BLUE BAND.

FIG. 1

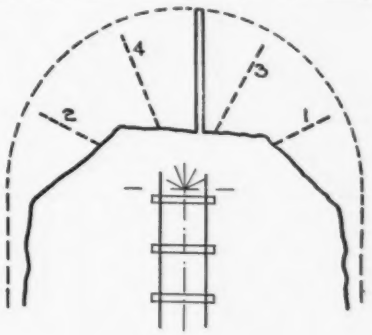
But neither one nor the other has done more than to hold temporarily the place of first importance, for just recently the track mounted undercutter not only makes its bid for a share of the respect and admiration that has been accorded the two "Old Faithfuls," but goes even farther than that and virtually demands recognition as the superior in every respect to all the others.

This new arrival is even more versatile than the job in southern Illinois requires or may ever require. In its more highly developed form it slashes across the coal face at any point from roof to floor. It then turns part way over in its heavy framework and makes deep shearing cuts in the face just about anywhere they are wanted. It starts backing out under its own power even before its mutilation is quite finished and with the final revolution of the cutter chain it is on its way to the next place to do the same thing all over again. In its simplest form it cuts across the face at or near the bottom for any width desired up to more than 30 ft., the cutter bar swinging in the arc of a circle. After sumping, or when cutting full width, the machine remains stationary on the track and secured by jacks to roof or rib. There is no unloading from a truck and prying into position against the face, and no loading up again when the cutting is finished.

The standard by which the usefulness of all machines may be measured is the amount of work they will do with the same complement of human labor. This standard applied to coal cutting machines is, in our case, responsible for the increasing popularity of the track mounted machine. It does about twice the work of the shortwall and nearly four times the work of a breast machine with the same labor cost.

Of the two types of track cutting machines now in use in southern Illinois, neither can be classed as more popular than the other. The coal is universally undercut and this practice will likely continue throughout the life of the field. The shearing machine or the combination undercutting and shearing machine finds favor locally where seam condi-

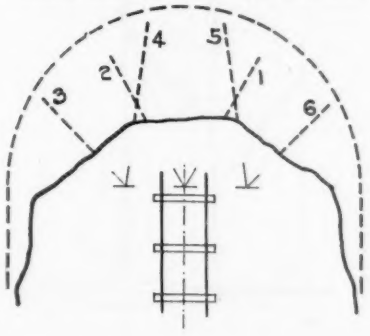
(*Continued on page* 32)



FOR HAND LOADING.
UNDERCUT AND CENTER SHEARED.
4 TOP HOLES FROM ONE POST SETTING.

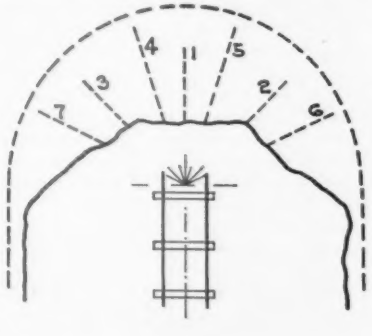
FIG. 2

* General Manager, Old Ben Coal Corporaton.



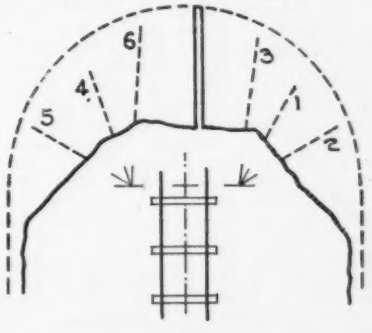
FOR MACHINE LOADING.
2 SNUBBERS, 4 TOP HOLES FROM THREE POST SETTINGS.

FIG. 3



FOR MACHINE LOADING.
3 SNUBBERS, 4 TOP HOLES FROM ONE POST SETTING.

FIG. 4



FOR MACHINE LOADING.
UNDERCUT AND CENTER SHEARED.
2 SNUBBERS, 4 TOP HOLES FROM TWO POST SETTINGS.

FIG. 5

GATHERING METHODS developed for mechanized loading

*By R. J. Oldham**

THIS paper describes the haulage system developed and used for gathering coal loaded by Joy machines at No. 5 mine of the Centralia Coal Company, Centralia, Marion County, Ill. The vein which is worked is the Illinois No. 6, which at this mine lies at a depth of 600 ft. Cars are hoisted in self-dumping cages.

The mine was opened in 1908. Mining was done by hand until 1912, at which time electric undercutting machines were introduced. In November, 1927, hand loading was discontinued in favor of mechanical loading. During the first few years of operation, mule haulage was employed. Five and 6-ton electric locomotives of the cable-reel type subsequently replaced the mules, and this same equipment is being used today. Little change was made in the design of mine cars from the days of mule haulage until mechanical loading was started. It is to be remembered that this is a shaft mine, hence it is impossible to change the design of mine cars materially without enlarging the shaft. All of the cars in use before mechanical loading were of wood construction. Their capacity on mechanical loading was 2.7 tons. The wheel base was 24 in. Most of the cars were equipped with plain-bearing wheels. Although this short wheel base is desirable on mule haulage and is not considered a serious obstacle while hand loading was employed, it was found to be a serious source of trouble on mechanical loading. It was necessary to load the center of the car first, otherwise it would derail itself. This necessitated a number of extra moves of the car while being loaded by the loading machine. Steel cars having a wheel base of 34 in. are gradually replacing the old-style car.

The room-and-pillar system of mining is employed. Panel entries are driven to a depth of 19 rooms. This depth of panel has not been changed from that which prevailed on hand loading. Rooms are driven to a depth of 300 to 400 ft. on 50-ft. centers. They are usually 25 ft. in width. All crosscuts between entries and between rooms are driven at an angle of 45 degrees on approximately 60-ft. centers. No right-angle crosscuts are used at any place. These angle crosscuts, commonly called "forty-fives," are more easily driven. They facilitate movement of the loading machine, and as track is laid in most of them, long radius curves are easily obtained. Roomnecks are driven at an angle of 45 degrees with the entry for these same reasons.

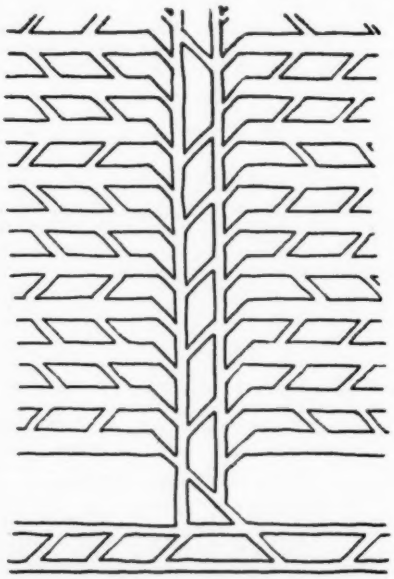
Track in panel entries and room switches off panel entry tracks are laid with 30-pound rail. Number 3 frogs are used. Track and switches in rooms are laid with 25-pound rail. Curved turnouts having the wing rail and filler rail integral with the frog are being substituted for old-style switches.

The actual gathering of the coal with our equipment and layout as stated above is as follows:

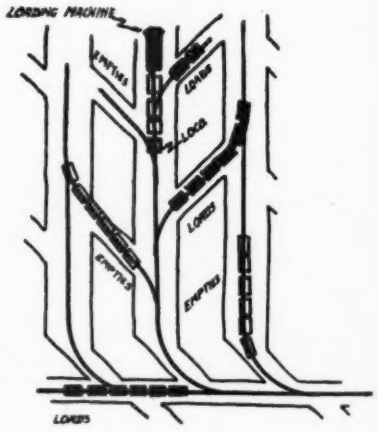
A relay locomotive, or swing locomotive as it is called locally, operates between the parting or side track and the gathering locomotive, which serves the loading machine. This gathering locomotive is a distinct unit and does not leave the immediate vicinity of the place in which the loading machine is working. The operation of these locomotives is explained more fully later. The main-line locomotive operates between the parting and the shaft bottom. After the main-line locomotive places the empty cars on the parting, which is planned so that it will serve two and sometimes three loading machines, they are delivered to the gathering locomotive serving the loading machine by the relay locomotive. Twelve or 14 cars are delivered to a gathering locomotive each trip. These cars are placed by the relay locomotive in the room adjoining the place in which the loading machine is operating or, if the rooms are of considerable depth, the cars are placed in a 45-degree crosscut off of the same room in which the loading is being done. Track is placed in this crosscut for this purpose. The idea is to have the empty cars stored as near the point of loading as is possible. This enables the gathering locomotive to make a more rapid car change for the loading machine.

The gathering locomotive takes the empty cars, usually three or four at a time, from the room or crosscut where the relay locomotive has left them, and pushes them to the loading machine. This locomotive remains with the empty cars while they are being loaded. The trip rider stands near the car and signals the motorman to move the car backward or forward to facilitate loading the car to capacity. When the car is loaded, the gathering locomotive pulls the loaded car to the entry or to a crosscut within the room. These loads are pushed back just far enough to clear the track in the room. The locomotive then returns to the machine with the remaining empty cars. The same procedure is repeated until the machine has loaded all but the last one of the original trip of three or four empty cars. When the locomotive has placed this last car at the loading machine it leaves the car and goes after another three or four empty cars while this last car is being loaded. This same procedure is followed throughout the day. The maximum distance that the gathering locomotive travels in handling loads or empties seldom exceeds 125 ft. The relay locomotive takes care of cars which are loaded by hand with machine cuttings and bottom coal. This method of gathering hand-loaded cars assists in reducing delays for the loading machine, because these cars are usually scattered. If they were pulled by the gathering locomotive the loading machine would necessarily wait, after loading the car under the machine, until the gathering locomotive would return to make the car change.

When the loaded cars have been placed on the entry, or in a crosscut close to



SKETCH SHOWING METHOD OF DEVELOPING PANEL



SKETCH SHOWING TYPICAL LAYOUT

*Superintendent, Centralia Coal Company.

the point of loading, by the gathering locomotive, they are pulled to the parting by the relay locomotive which has at the same time delivered an additional supply of empty cars. The main-line locomotive takes the loaded cars from the parting to the bottom.

The one relay locomotive serves two and sometimes three loading machines, depending upon conditions. The partings are as centrally arranged for several machines as is possible. By this method the one locomotive, motorman, and trip rider pull 275 to 325 cars in an 8-hour shift.

The advantages of the method described have been made apparent by taking time studies on loading operations. Time studies were started with the beginning of mechanical loading and are still run intermittently on each machine. The delays for the entire operation are shown here. After the cause of a delay is ascertained, a means of eliminating it is sought. The information obtained through these time studies has led us to adopt the gathering method we now use.

The time consumed in changing cars at the loading machine is reduced to a minimum with our present system of gathering. The average time required to pull the loaded car from the machine and place the empty car at the machine averages 1 to 1¾ minutes, depending upon how far the locomotive travels to dispose of the loaded car. As stated before, this distance never exceeds 125 ft. The time consumed by the gathering locomotive in going after empty cars is reduced by having the empties placed as closely as possible to the loading machine.

The advantages of the gathering method described are as follows: (1) The time consumed in changing cars is reduced to a minimum. (2) A minimum number of men per switching crew is needed. As brought out in this paper, these are accomplished by having the one relay locomotive serve several gathering locomotives, and by reducing to a maximum of 250 ft. the distance which the gathering locomotive must travel to make a car change. Of course, this method requires the laying of additional switches, but we are convinced that the time and expense required for the extra switches are more than justified by the results obtained. Confusion and congestion at or on the parting are reduced to a minimum because only the one relay locomotive and the main-line locomotive operate at the parting. This method has worked satisfactorily under our conditions, and we feel that it is efficient and economical.

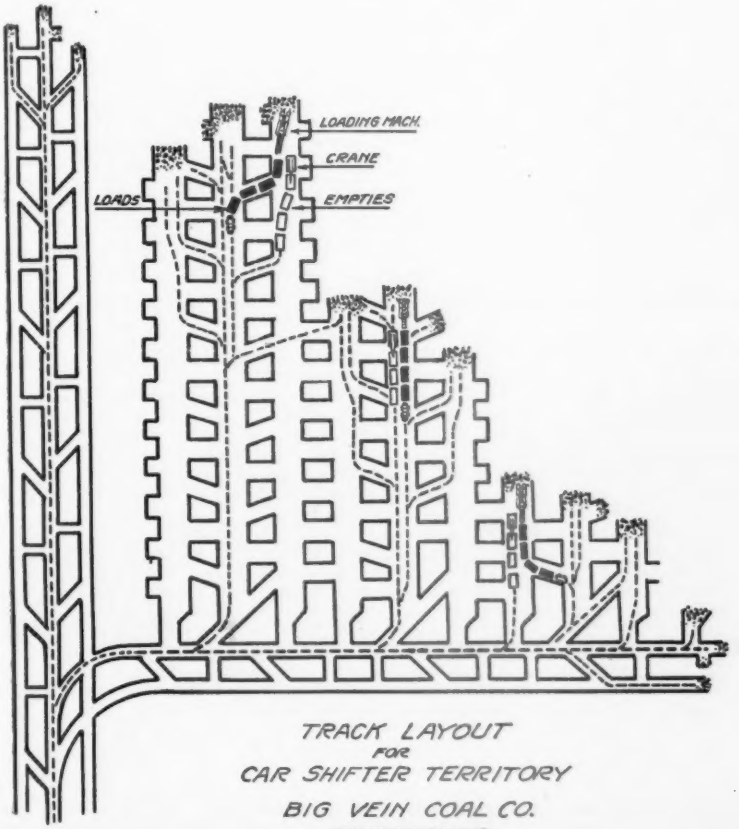
The attached table gives the daily loading by six Joy machines during a recent month. Their performance is remarkably even and the tonnage loaded is good.

CARS LOADED BY SIX JOY LOADING MACHINES DURING JANUARY, 1930

Date	Machine number 1	2	3	4	5	6
2	123	90	95	122	109	101
3	123	97	122	113	113	115
6	104	103	100	125	100	111
7	130	102	112	117	96	99
8	93	116	117	116	118	122
9	114	111	114	106	103	101
10	120	102	109	118	128	119
11	106	95	117	121	113	111
13	131	119	113	91	104	95
14	125	107	98	96	103	103
15	116	106	132	80	112	129
16	119	97	119	92	107	95
17	125	90	92	82	112	132
18	111	95	96	99	99	92
20	98	115	115	116	134	102
21	116	80	108	92	117	121
22	106	90	82	87	119	116
23	115	110	118	104	89	81
24	119	101	109	121	106	138
25	102	102	100	112	121	120
27	133	125	97	109	106	88
28	88	126	104	114	103	115
29	119	117	117	94	115	112
30	121	138	117	110	94	94
31	102	117	110	112	124	103
Total cars loaded	2,859	2,651	2,713	2,649	2,745	2,715
Avg. cars loaded per day	114.4	106.0	108.5	106.0	109.8	108.6

DISCUSSION

Gathering Methods Behind Mechanical Loaders



TRACK LAYOUT
FOR
CAR SHIFTER TERRITORY
BIG VEIN COAL CO.
BUCKSKIN, IND.
JUNE 2, 1930.

Chas. Gottschalk, *Big Vein Coal Company, Buckskin, Ind.:*

Serving the loading machine with mine cars is a problem as old as the first loading machine. A study of the various methods employed to date to give continuous car supply reveals that by going to sufficient expense this hope has been realized. If our observation is correct, the best results of record so far have been accomplished by use of two storage battery locomotives, and a switch through each room cross-cut, and a connection with the room track in the adjacent room. While this solves the problem from a purely mechanical standpoint, it does not always do so from an economical point of view. The arrangement of tracks in the above system calls for a double investment in switches and track labor, and an extra locomotive, where possibly the generators are overloaded to begin with.

On the other hand, our studies and observation of studies of others shows that the average car change interval is around two minutes. We have had results as good as to fall within a period of one minute, but over a long time two minutes would be closer. We finally figured out an arrangement whereby the change could be made in 15 seconds, and concluded that in practice 30 seconds would be more nearly the result. By reducing the change interval from 2 minutes to 30 seconds meant for us that at least two hours more productive work would be gained by the loading machine per shift. We therefore felt that our plan deserved a test. Our plan seemed to have the following advantages over the two-motor idea: Extra switches were eliminated; instead of a 6-ton locomotive, requiring 60 hp., the substitute machine required but 7 hp. and cost less than one-half the price of another locomotive.

The car shifter discussed by Mr. Gottschalk

The plan, which is very simple, consists of laying double track in each room for a distance of not less than 100 ft. from the face. A revolving mine crane follows the loading machine into a room. A trip of empties are then delivered to the crane. As fast as a car is loaded, the crane sets another empty over to the load track until the place is loaded out.

The accompany photographs describe the machine better than words. In designing the machine the main thing kept in mind was that it must work in any place the loading machine served. The machine will swing an empty car from one track to another in five seconds, and will lower and release in another five seconds. The balance of the interval is required in coupling and pushing by gathering locomotive to loading position. During the two months that the machine has operated, the maintenance cost has been nothing. So far no arrangements have been made for marketing the crane, but application for patent has been made by the inventor.

Carl Lee, *Peabody Coal Company:*

First, in regard to Mr. Gottschalk's scheme, if we had the natural conditions shown in that picture, where we could put in two tracks, we wouldn't need the jib crane to handle the car. Why not load on two tracks; first one and then the other? We would do as well as with a jib crane trying to move cars from one side or the other.

In regard to Mr. Oldham's paper, in order to bring out a little discussion, I would like to argue the point on the lengthening of the wheel base of the cars. It looks to me as though that were rather an expensive thing to do. We are operating a number of Joy loading machines, loading pit cars approximately the same size, if not a little larger, with 14-in. wheel base.

We have no trouble with cars tipping off the track; at least, it hasn't proven serious. In fact, we have practically the same scheme of loading that Mr. Oldham is using. We have the same scheme of switching. The gathering locomotive works right up against the loader, has hold of the empty car or the car which is being loaded, and that locomotive can switch the car back and forth a few feet at a time, or just as required to keep the loading machine in the front end and the back end, and keep the load divided so the car will not tip over. The loading machine moves backwards and forwards so that the pit car has to be moved anyway.

On the number of cars per day, we notice from statistics or data which he has furnished, that he is averaging a little over 100 cars per day, which checks very closely with the average that we are getting under, I would say, very similar conditions. We didn't go into the angle of crosscuts or the angle of room necks as far as Mr. Oldham did. There is one question about the weight of coal in the pit cars by hand loading. I am not clear as to whether the figure 2.7 tons refers to hand or mechanical loading or to mechanical loading with a small car.

MR. OLDHAM: Two and seven-tenths tons represent mechanical loaded cars—an average of 6,800 on the cars handled.

MR. LEE: That is the point I wanted to bring out—6,800 with mechanical and 5,400 with hand loading, approximately 80 percent. We have found the same reduction in the average weight of coal, and to overcome that we have been putting on side boards on the cars, which brings up the average 200 or 300 pounds per car.

Coal Cutting and Face Preparation With Track Machines (*Continued from page* 29)

tions may give a greater percentage of lump from coal that is sheared as well as undercut, but the undercutting predominates in importance and will always be the first requirement.

The advent of track cutting machines has brought with it the necessity for better track at the face. These machines are heavy and, when sumping in, must depend entirely on the track for stability; furthermore, the track must be extended to within 4 or 5 ft. of the face after each cut is loaded out. General practice is confined to two ways of doing this: Laying short pieces of rail equal to or a multiple of the effective cutter bar length until a full length rail can be substituted, or using full length slide rails on special steel ties. The latter method will probably become universal and is especially advantageous where caterpillar mounted loading machines are used and it is desirable to remove the track from the working area of the loading machine. Generally in the field all coal bottoms are left in place as a shoveling floor. Where only light rail is available a strip of bottoms is taken up just wide enough to admit the track. This permits the use of old light-weight rail that would otherwise have to be discarded as too flimsy to support the heavy machine.

The most radical departure from the old order is the arc shaped face with the undercut coal in the form of a quarter moon. This, without question, is our greatest problem. We have to blast out an arch by applying the blasting medium at such points and in such manner that a minimum of its force will be wasted in overcoming the inherent stability of the arch, and, at the same time lay the coal down with the least amount of fines and shattered lumps. There is a wide difference of opinion and practice in the field which in itself indicates the absence of complete success in coping with the problem. The accompanying sketches illustrate some of the methods in use and are largely self-explanatory. For hand load *Figure 1* shows the method in most general use at the present time, while for machine loading *Figure 4* and *Figure 5* seem to predominate.

Topholes are invariably drilled level and about 1 ft. below the roof line. Snubber holes vary in depth and may be level or sumping as much as 30 degrees from the horizontal but always so that the explosive charge is above the blue band.

No doubt remains in the mind of anyone that the track mounted undercutter has come to stay. Refinements and improvements are inevitable and the basic principle is sound. Whatever difficulties there may be with the circular face will be overcome and forgotten in a very short time. Our coal field is well suited to its use and there now appears to be no obstacle other than the purchase price in the way of its universal adoption. The old breast machine, our first love, must go. The shortwall, like its predecessor, will for some time to come have a place of usefulness in long face work and other systems of concentrated mining and may still be found at work in our mines for another 15 years.

POWER in Mechanical Mining

By Carl Lee *

No doubt there are many present who can recall earlier mining experiences where the question of power was not of mechanical power but of mule power. Coal was mined by hand, shot down with powder, loaded by hand, and pushed to the room neck by hand power, then hauled to the tipple by mule power, and dumped by hand over end dumps or similar devices directly into railroad cars. Without going into the history of intermediate development we will approach the present-day problem where in many mines practically all work previously done by man or animal power has been taken over by mechanical power, which means today, by electrically driven devices.

In the recent years the last step of this mechanization has been the addition of loading machines with the auxiliaries for serving them and to round out properly proportioned operating groups.

This paper is confined principally to the inside of the mine, as the problem of preparation has not been much standardized. Inside the mine we find that the main-line haulage has changed little. The pit-cars are not loaded so heavily, hence there is a slight increase in the power consumed because of the increase in the tare weight of empties handled to produce a given tonnage.

From the main-line haulage on inside, conditions have changed materially. Where gathering locomotives serve loading machines we find that the practice has been to add to the number of gathering locomotives so that the loading machines will be served with minimum delays. This is in order that the loading machine may make the best showing for itself as well as improve the overall performance of the loading group. By this arrangement there is approximately 50 per cent increase in the connected load of gathering locomotives, though not that proportional increase is peak loads or power consumed.

With mechanical loading it has been fairly general practice to add power drills, so that the drilling can be done economically by labor paid by the day. While this is not a large load, it is fairly steady and adds to the demands on the power system.

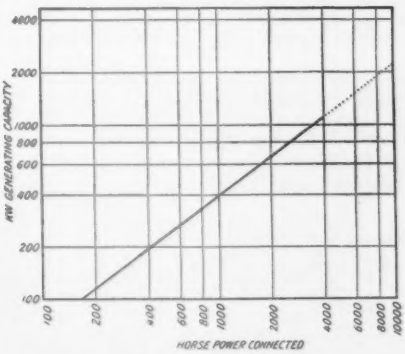
Also, with the mechanically equipped mine it has been common to undermine the coal with machines operated by day labor. This has led to the introduction of more powerful machines designed to undercut practically twice as much as was possible with the type machine most commonly used heretofore, namely, the shortwall. This is accomplished by the machine being so designed that it cuts the room or entry while standing on the track. Thus the lost time and effort of the runner in unloading the machine itself and a considerable quantity of tools, jacks and accessories is saved with the track-mounted cutter. This saving, together with the larger motor used, results in a reduction of the horsepower of cutting equipment per ton mined, but a considerable increase in the demand and use of the motor equipment so installed.

Finally, in equipment, the loading machine itself is entirely new to the field and is an added function that power has taken on to relieve the human effort in producing coal. The amount of power required is not great per ton of coal, probably not exceeding 0.5 to 0.7 kw.-hr. for average conditions, but taken as a whole for an entire mine it has to be considered.

Now, inasmuch as each mine is a case to itself, no exact formula can be offered which will fit all mines and that can be used to determine what generating capacity will be required and what size of feeders will be necessary for a given tonnage of mechanically mined and loaded coal.

We can approach the problem in such a way that close results can be obtained, following an examination of the mine and the adoption of a definite plan of operation. That is to say, it is necessary to know the hardness of cutting at the point selected by the management; the grades to be encountered by locomotives; the height of coal and size of cars, conditions of roof, etc., so that some approximation can be made of the performance of the loading machine.

With these facts and having decided on the number of the various pieces of equipment of all kinds to be used, we may then approach the problem of power supply. First, the size of generating equipment must be determined. This is governed closely by the horsepower in connected load, though not in exact proportion. The results of a study of considerable data indicate that the relation



On the chart showing horsepower connected and corresponding kw. generating capacity the actual data obtained has not run beyond 4,000 hp. connected load; hence a dotted line from that point on indicates lack of actual data.

In case the total connected load is fed by two or more separate generating stations and where these stations may be some distance apart so that there is a natural division of load, then the generating capacity for any substation should be figured on that part of the load which would be naturally supplied from the substation in question.

as shown in the accompanying chart is correct enough for ordinary conditions.†

Again, having the size of generator required, the problem of copper feeder lines, both positive and negative arises. The size is not governed by the size of generators alone, but that in combination with the distance that the power has to be transmitted. Thus, both have to be considered and the size increases in proportion to their product to secure similar results.

For example: assume a case where a 300-kw. generator is required and the average current is 1,090 amperes, and where the distance is 2,000 ft. Then, on the assumption that 220 volts average is required at the face with 275 volts generated, the loss in the lines, both positive and negative, can be no more than 55 volts; hence, by basic laws for calculating size of wires, we find that 800,000 c. m. (circular mils), is required on both positive and negative. Now, if either the average current or the distance is doubled, then the size copper should be doubled. If both are doubled, then the size copper has to be doubled twice, or 3,200,000 c. m. on both sides. In this connection it might be noted that for a given load, when the distance is doubled the size of copper is doubled, and at the same time the length of copper is doubled, so that the quantity in pounds of copper is doubled twice. Now, this is where the principle thought to be brought out in this paper may be presented. This should be borne in mind by the superintendent and other executives who pass upon the adequacy of power supply at the face, at those mines equipped with mechancial loading or who contemplate so equipping existing mines.

Mechanical loading with the auxiliaries required will increase the power load inside the mine by possibly 50 per cent above hand loading. Also, when working with mechanical loading paid for on a day wage basis it is important to keep the equipment going at nearly full rated speed. This requires a much higher standard of power supply—that is, average voltage—than with hand loading. Hence, with the increased load and the better service required it is imperative that liberal amounts of feeder line be installed. The foregoing figures may be used as a general guide. Where the loads are fairly large and the distances great it is advisable to make a close check to determine if it would be more economical to install substations near the load centers.

By using substations at or near load centers it is possible to carry the power from the supply at the main plant to the motor-generator set, at 2,300 volts or above, as required by the distance. This is more economical as the loss in the copper is greatly reduced at the higher voltage.

DISCUSSION

Power in Mechanical Mining

R. L. Kingsland, *electrical engineer, The Consolidated Coal Company:*

I believe that Mr. Lee has pointed out the principal troubles that are experienced in getting adequate voltage to our faces. In looking over his chart it is rather startling to see that with 10,000 hp. connected load we only need 20 percent of it in power capacity, generating

(*Continued on page* 40)

* Electrical Engineer, Peabody Coal Co.

† For a more complete reference see Journal of the Western Society of Engineers, vol. XXVI, No. 10, Oct. 1921, pages 337 and 350.

The use of Graphic Cost Charts in Mechanized Loading

By **W. L. Affelder** *

AT THE meeting of the American Mining Congress, held here in 1925, I presented a paper entitled "The Advantages of Graphic Charts in the Interpretation of Coal Mine Costs." At that time our company had been using graphic cost charts in connection with the labor costs of about 20 mines for a period of a little over a year. The system is now in its seventh year and has been very much improved and extended to include supply costs and a detailed cost system covering the operation of 22-room and entry conveyors, all of which have been in use in one of our mines for varying periods up to a little over four years. From an initial installation of a single conveyor unit of the drag-chain type, the monthly output of conveyor coal in this mine has increased to a maximum of 25,500 net tons, or 30 percent of the output of the mine, with as much as 7,166 feet of entries driven by conveyors in a single month.

It would be an almost hopeless task to endeavor to follow the detailed cost data of a large number of mechanical units from actual figures. On the other hand, it would be folly to operate any mine, either wholly or partially, on a mechanical basis without having sufficiently itemized cost data in such shape that the figures can be interpreted easily and quickly by a mining man of ordinary intelligence. In 1929 the range in the extreme semi-monthly average production cost of all of our conveyors was 13.5 cents, while the range in an individual conveyor was as high as 60 cents per ton. These variations in cost are, as a rule, fully justified by varying operating conditions, but records should be in such shape as to make unusual variations stand out in a manner that will require no unnecessary study in locating their presence and their cause.

We show a production of about 11,000 tons in each half of January, and a decline of about 7 cents per ton in total cost in the second half in spite of an increase of about 4½ cents in labor. There was an increase of about 4 cents in loading labor, which accounts for practically the entire labor increase. This was due to a readjustment in the wage scale, whereby the loading rate was increased sufficiently to permit of the elimination of the practice of the company furnishing explosives free. There was a corresponding reduction of about 3½ cents in the cost of explosives. Supplies, excluding explosives, dropped from an unusually high cost of 8.6 cents in the first half of January to an unusually low cost of 0.6 cent in the second half of the month. Fluctuations of this kind are inevitable in any type of mechanization. The higher cost figure was due to the replacement of a number of worn-out chains. Unfortunately, the lower average figures do not always predominate. The increase in feet of entries driven in the second half of January to 2,224 feet, as compared with 2,087 feet in the first half, was reflected in the increase in yardage cost from 5.0 cents to 5.2 cents.

The production in each half of February was slightly over 9,000 tons. The labor and the supply costs were practically the same in both halves of the month, in spite of a drop of over 400 feet in the amount of entries driven. This drop was evident in a decrease of 0.7 cent per ton in yardage cost and a decrease of 1.2 cents per ton in deadwork cost, but these decreases were offset by an increase of 1.5 cents per ton in the cost of moving machines and several other increases of a minor nature.

The production in each half of March was between 8,000 and 9,000 tons, the declining production keeping pace with that of the entire mine and remaining at about 30 percent of the entire output. The labor cost in the second half was 4.8 cents higher than in the first half, but the supply cost declined 1.8 cents, reducing the total increase to only 3.0 cents per ton. The increase in labor cost in the second half of March was due to an increase of 2.7 cents in deadwork and 2.4 cents in moving machines, the latter figures fluctuating with the moving of conveyors from old locations to new points.

We have kept the individual records of six conveyors, showing total cost, tons produced, and the feet of entries driven. The drop in total cost of No. 7 conveyor in the second half of March, as compared with the first half, amounting to 27 cents per ton, was found upon investigation to be due principally to decreased costs in yardage, deadwork, moving machines and supplies. In the case of No. 10 conveyor, the increase of 19.4 cents per ton in the second half of March was due to increased costs in deadwork, moving and repair labor. Conveyors Nos. 8 and 9 did not show sufficient change in cost to necessitate any special investigation. The true value of this method of keeping in touch with costs is thus shown in pointing to the units which could bear investigation.

No graphic cost system is applicable to the problems of all mines, but some system should certainly be used in every mechanized mine whereby the executives and minor officials can interpret costs quickly and accurately.

* Vice President in Charge of Operations, Hillman Coal & Coke Company.

Exhibits in North Hall at the Cincinnati Exposition

Large Haulage Locomotives . . . for Long Hauls

By G. G. Kanable *

IN discussing long hauls and large haulage locomotives, the terms "long haul" and "heavy locomotives" are to be considered as relative and not to be assigned definite values, because a long haul in one mining section would be considered a short haul in another, and a heavy locomotive in one section would be classed as a comparatively small one in others. For purposes of discussion, therefore, we have assumed the large locomotive to be one which has been developed to meet a demand, and applied to meet the conditions imposed by it.

For the same reason the long haul has been assumed to be one the major portion of which is inside the mine and through development or some other cause has become cumbersome and inefficient. This is one problem for which we are seeking a logical solution.

It has been assumed that grades are such as to admit of the efficient use of locomotive of such size and construction as will fall under the general head of large locomotives.

It may be interesting to note some of the changes of conditions in the mining industry which helped to bring about the necessity for them.

In earlier years, long and heavy hauls were not necessarily a serious problem; first, because the mines were not sufficiently developed to bring up the question of long hauls. Second, in such mines as found their hauls becoming too long, the coal bed was opened in another location, a comparatively cheap tipple was erected, and the question of long haul was evaded.

Today, the average mining company finds itself with expensive tipples and cleaning plants made necessary by demands of the consumer for clean coal, and as it is out of the question to move the plant to the coal, it has become necessary to move the coal to the plant; the result of this being that many of these companies have conditions in which the cars are switched several times, and handled by several locomotives before reaching the tipple.

As an example, assume a mine employing one haulage locomotive from a side track to a tipple, efficiently handling a given tonnage, increased tonnage demands, or necessity for moving the side track nearer the workings, may throw the haulage out of balance and destroy this efficiency.

This condition is usually met temporarily by overtime at tipple and overloads on the existing locomotive, resulting in a decrease in tipple efficiency in the first case, and locomotive troubles in the other.

The most obvious remedy is the addition of another locomotive of similar size and speed to the main haulage, which will meet both conditions, but requires the added expense of a motorman and frequently a brakeman for the added locomotive, and will possibly require a passing side track.

By the addition of one locomotive of twice the weight of the original, the same result may be obtained without the necessity for a siding, saving the wages of at least one man, and releasing the original locomotive for other work.

Where secondary straight hauls are used between main and auxiliary side tracks the same problem may come up on any one or all of these hauls, and will probably be solved in a similar manner.

The weight of locomotives to be employed in any one case to improve haulage conditions should be decided by the conditions existing at the particular colliery in question. In support of this, the catalog of a prominent manufacturer has this to say:

In compiling the data here given, no attempt has been made to establish a given standard, but rather to place in the hands of the various salesmen such descriptive information as will assist in the selection of a locomotive best suited to any given customer's requirements.

Regardless of the weight of locomotive desired, we find many instances where conditions, such as low roof and narrow headings, determine the size that can be used. It is not unusual to find that it is impossible to install one locomotive of the size desired, and it has become common practice in such cases to use two smaller locomotives of the same inherent speed, with a single control, or to add a third truck in a single frame and apply another motor.

Possible Effect of Large Locomotives

It must not be assumed from the foregoing that the large locomotive is a cure for all haulage difficulties; in fact, it is entirely possible for the large locomotive to introduce many troublesome factors on its own account. Some of the points affected are trackage, trolley and feeders, generator capacity, mine cars, and, in the case of purchased power, load factor and demand.

Mine tracks that have been satisfactory for the previous haulage will quite often be found to be entirely inadequate for the large locomotive.

Trolley and feeders which previously provided satisfactory operating conditions may not be of sufficient size to prevent undesirable fluctuations in voltage which may affect other apparatus adversely.

Increased demand, with its consequent effect on generator capacity and load factor, are also points to be considered when large locomotives are introduced. The question of expense other than the cost of locomotive, in connection with the installation of heavy locomotives, can not be overlooked or what was at first intended to be a solution of a problem in haulage may resolve itself into a bill of expense. In a great many instances this expense auxiliary to the cost of the locomotive will be found to demand the most serious attention.

It has been assumed thus far that the long haul affects both the high and low vein coals. Also that the locomotives spoken of were available; but it may be interesting to note the effect on other industries more or less related to mining, and affected by its problems.

What Locomotive Manufacturers Have Done

For instance, what have the manufacturers of mine locomotives been doing to follow the demands of the haulage problem?

The earlier locomotives were usually installed as an adjunct to animal haulage and, regardless of size, were considered haulage locomotives. These were used principally to haul from side track or gathering points to existing rope hauls.

The duty of these locomotives was not especially severe, and it was general practice to use sleeve bearings throughout and it was quite usual to use a motor on only one axle. As a rule, the weight of such locomotive was 4 to 6 tons, and the horsepower of motor per ton of weight very low.

As the demand for heavier locomotives increased, the manufacturers increased weights of frame, added steel tires to wheels, increased horsepower per ton, and applied antifriction bearings to the armature shafts, which is now general practice.

The subject of horsepower per ton, horsepower rating of motors, and available space in locomotive frames became a serious proposition, because the space limitations before referred to would not permit the use of motors of the required horsepower, nor accommodate the necessary size of resistor in the frame space available. As the length of hauls increased the idle time of the locomotive was cut down until troubles due to overheating developed. This brought into use artificial cooling of motors by means of fans or blowers, thus increasing the rating of motors and permitting their operation at rating, for a longer period of time or above rating for a shorter period, without injury.

The following figures showing gradual increase in horsepower per ton of locomotive weight were compiled from data furnished by a prominent manufacturer of locomotives and are closely representative of the practice of other manufacturers:

For gathering locomotives, horsepower per ton on what is now obsolete equipment varied from 6.66 to 7; later types, 9.25 to 9.6; and for modern types, 10.

For haulage locomotives these figures for obsolete equipment varied from 6.46 to 8.4 horsepower per ton, up to 20 tons of locomotive weight. Later types, 10.3 to 13.5, and for modern types, 12.5 to 17.3 up to 30 tons of locomotive weight.

As an indication of what is now general practice, the following table has been compiled to show locomotive weights and conditions under which they are operated, covering a wide range of locality, and may be taken to be fairly general practice.

* Chief Electrical Engineer, Rochester & Pittsburgh Coal Company.

Locomotive weight, tons	Length of haul, ft.	Average grade percent	Maximum grade for trip lengths percent	Cars per trip	Gross weight of cars, lbs.	Kind of bearings	Type of hitchings
20	7,100	2.04	4	40	226,000	Sleeve	Link and Pin
20	5,700	2.02	5	35	195,750	Sleeve	Link and Pin
25	11,200	0.42	2	60	552,000	Anti-fric.	Swivel
1–20							
1–15	4,600	4.0	5	40	148,000	Sleeve	Link and Pin
2–20	6,300	4.0	6.5	30	318,000	Anti-fric.	Swivel
2–20	7,000	5.5	8	20	187,000	Anti-fric.	Swivel
2–10	2,400	4.9	7.5	20	210,000	Anti-fric.	Swivel
1–15							

Improvement in Mine Cars

The question of mine cars and what the manufacturer has done to follow the trend to large haulage locomotives should be mentioned.

The most natural source of troubles coming through the use of heavy haulage equipment was strength of drawbar, bearings, coupling pins and links. The drawbar has been increased in size and reinforced in many ways. The size of coupling pins has been increased, while links were developed from old welded types of different sizes to the modern punched-steel link. Swivel hitchings are quite generally applied, and in some cases automatic couplers similar to railroad cars are used.

The use of anti-friction bearings on long hauls has become practically standard because, while sleeve bearings have sufficient area to prevent undue heating on short hauls, they gave trouble from this cause on the larger ones, and in some cases prohibited their use.

In general, the mine car is being more ruggedly constructed. It is being made of all or part steel construction, general preference being given in some localities to the part steel with wood bottoms and bumpers, giving the car greater flexibility and shock absorbing qualities. It is being made as large as is consistent with the physical conditions imposed by the mine where used.

Future Haulage Problems

It may be of some value to inquire into the solution of some of the future problems involving even longer hauls than a great many of the ones so far considered, and the means by which it may be accomplished.

The question of track equipment does not require much comment, as rail and fittings are made in any size to meet any normal requirements. Ties are available, from creosoted wood to steel and concrete.

The manufacturers of mine cars will build them to any practical size. It is entirely possible that the mine car of the future will be built similar to railroad cars, run through entries shot to sufficient size to accommodate them, over miniature railroads with signal systems, automatic switches and safety devices, to dumping points miles inside from the mine opening.

The locomotive hauling such trips will be of commensurate size, have antifriction bearings throughout, blower-cooled motors, contactor control, air brakes, air-sanding devices, steel wheels, and third-rail collectors, etc.

There are systems in use at present incorporating a great number of the car and track features mentioned, and locomotives such as described are available today in any practical weight.

From the foregoing, and other information not mentioned, we may arrive at the following more or less general conclusions:

The long haul is a problem with which the average mining company has to contend today.

The solution of this problem has quite generally been through the use of heavy locomotives. The desirability of employing heavier locomotives was indicated a few years ago by the observation of a prominent manufacturer, "that in the selection of locomotives it is unquestionably general practice to select sizes too small and to use too many units."

The heavy locomotive will possibly introduce problems peculiar to itself, such as larger rail, better roadbed, increased demand for power and additional car equipment, or improvements on that existing.

It is very probable in many instances that it will be necessary to rebuild the haulage system on the mine around the heavy locomotives, because delays are large factors in the success of long hauls.

The limit of size is governed by the conditions under which the locomotive is to operate, and should be decided by a thorough survey of the particular installation in question.

Economics of Large Locomotives

Giving due consideration to the foregoing, we are lead to believe, in the majority of cases, that the capital expenditure necessary to build and maintain good tracks, purchase and install large locomotives and mine cars, and provide ample power, can not be justified on small daily tonnage outputs (1,200 to 1,500 tons); but in the majority of cases it is necessary to have a daily capacity in excess of 3,000 tons to justify the capital expenditure necessary to install and operate long and heavy haulage systems. In addition to this, it is absolutely essential that these locomotives and mine cars are kept in continuous operation. There must be a minimum number of delays; loaders, whether hand or mechanical, must be serviced with regularity and efficiency. To maintain a high degree of efficient operation, it is essential to have a train or load dispatcher with the necessary telephone equipment to keep the entire haulage system moving in unison.

For purposes of illustration, we may cite the following:

A certain mine having a haul of about 2 miles was required to increase tonnage.

A time study of tipple performance was made. and the following facts were tabulated from an analysis of this study:

It was found that out of the available dumping time, 68 percent was occupied in dumping, 5 percent in tipple changes, and 27 percent waiting on coal; 65 percent of this time lost in four particular hours of the dumping period.

After ascertaining when and how much time was available for improvement, a time study was made of the mine haulage to determine the cause of the uneven delivery of coal to the tipple. This condition was found to be caused by several factors—namely, main haul too slow and of insufficient capacity; poor track conditions; insufficient side tracks; and lack of coordination in the several units making up the haulage system of this mine.

Acting on conclusions drawn from an analysis of the facts brought out by this study, a system of side tracks was laid out. The track system was improved by ballasting and laying of additional heavy rail. Two 25-ton locomotives were installed on the main haulage, having approximately 3 miles per hour more speed than the ones replaced. Ten cars were added to the trips hauled, an increase of 28 tons per trip over the old arrangement, and 50 percent of the tonnage hauled an additional 1,000 ft.

The necessary coordination between inside and main haul locomotives was obtained by the addition of a car dispatcher whose duties are to direct the main haul locomotives to such side tracks as have the necessary cars to make up a trip; to receive reports of arrival and number of loads and departure of empties at these side tracks, and from this information so schedule the locomotives as to have a minimum of lost time, and keep cars moving regularly to and from the face.

A time study after these changes had been put into effect showed the following results:

The average actual running time between extremes of haul was found to be 12 minutes for the loaded trip and 11¼ minutes for the empty, or a running round-trip time of 23¼ minutes. During this time the average delay per trip, due to interference at passing, was 2 minutes.

The unavoidable outside delays after landing trip of loads, such as switching, sanding up, etc., averaged 5¾ minutes. The delay inside should not normally be in excess of 4 minutes, making a round trip in approximately 31 minutes. This gives us a potential capacity of approximately 5,000 tons per day.

The net result of this change was the following:

Actual production of 3,500 to 4,000 tons per day.

Uniform delivery of coal to tipple, permitting a decrease of dumping speed, resulting in more perfect screening and preparation, and at the same time providing for an increase in tonnage handled by the tipple, through additional dumping time.

Increased mine tonnage.

Provision for further increase in tonnage and future extension of side tracks.

Increase in tons per loader, making for better labor conditions.

We believe that similar results may be shown on other hauls, provided that the proper steps are taken to determine the actual needs of the haulage in question, and provided that there is sufficient tonnage to warrant the expense.

DISCUSSION

Large Locomotives in Long Haulage

Charles M. Means, *consulting engineer, Pittsburgh, Pa.:*

This paper covers a very timely problem, as we are rapidly approaching main line haulage systems of materially increased capacity.

This has been brought about by the demand for larger cars for mechanical loading with increased tonnage, the desire to reach water transportation where

(*Continued on page* 37)

Increasing Capacity of Mine Cars

By F. S. Follansbee *

COAL mining, stripped of refinements, amounts to providing a given number of sufficiently well ventilated and drained working places, grouped in the smallest practicable area, and furnishing transportation for the coal from this area to the preparation plant.

Transportation in a mine is motive power, track and cars. Each one is dependent on the other two. Track and motive power may be 100 percent and the whole transportation system be inadequate because of the type, design or capacity of the car.

The one single feature of a mine car that may affect costs more than all other items combined is capacity.

A car may have roller bearings, spring draft gear, rustless steel, a perfect brake, unbreakable wheels, etc., and still cost more to operate than a car without any of these refinements, but with one-half of a ton greater capacity. This is not intended to belittle those improvements, for they are good investments and are needed on the large capacity car more than on the smaller.

The capacity of the car may affect production per miner, concentration of workings, first cost of the cars, production of the mine.

If a miner can load out his place with two-thirds the number of a larger type car than is required with the smaller, his percentage of time waiting for cars is decreased and loading time increased.

A mine may work one loader to the place and use the clean-up system. He loads five cars per day. It is decided, for the sake of economy, to work two men to the place and reduce the live working area to one-half the territory formerly covered. On account of bad roof conditions, timbers must be set so that it is not practicable to deliver two cars at a time. This means that the gathering motor must make his run 10 times per shift instead of five. This, in a great many cases, cannot be done and the small capacity car defeats this form of concentration.

A total of 625 cars would be required at this mine, when working 200 men in single places and the smaller cars at $170 would cost $106,250. With cars large enough to allow the gathering motors to serve double working places, 358 cars would be needed. These, say at $250 each, would cost $89,500.

A mine with a bottle-neck such as a shaft with self-dumping cages is limited in production by the capacity of the mine car.

A specific example of what increased capacity in a mine car will do to costs:

During 1928, a mine with a car averaging 3.24 tons dumped 575 cars daily and had an average production of 1,863 tons.

During the last 10 days of December a rotary dump was installed and the old end dump cars replaced by a solid end car.

During 1929, with practically the same number of working days, exactly the same number of cars were dumped daily, giving a production of 2,236 tons, an increase of 373 tons or 20 percent. The new car averaged 3.89 tons or 20 percent greater capacity than the old. The gathering motors averaged the same number of cars per day. Haulage costs were reduced 3.3 cents per ton and total costs 15 cents per ton. This on the year's production was $103,200, and the new cars cost $121,000.

The rotary dump, in turning a car bottom side up does not require that the car have a smooth bottom for the coal to slide over as in the end dump. Hence, the wheels, axles and bumpers may be housed inside the car and the bottom dropped to as near the rail as is practicable. This type of car gives the maximum capacity.

There may be pockets where wet coal will stick and cut down some of the capacity gained. Keep these pockets cleaned. If swivel couplings are used and the dumping crew reduced by three or four men, one of these men kept on as a car cleaner will still leave a reduction in day men. For a 1,000-ton mine using 2.5 mine cars, and dumping 400 cars per day, if this man is responsible for saving a decrease in production of seven tons per day, through increasing car capacity, he will pay for himself. This means that by keeping the cars clean he needs to add 0.7 cu. ft. to the capacity of each car.

Passing from the solid or rotary dump car to the end dump car, which in some cases must be used, we are limited to keeping a fairly smooth bottom for the coal to run over. The wheels may be housed to a certain extent, but if it is a through axle type, coal must pass over the axle.

The greatest capacity that can be obtained in the end dump car is with the stub axle type. The wider the track gauge, the greater the capacity, as the bottom between the rails can be lowered to the limit. On the 44-in. gage track, with a car body 10 ft. long inside, a ½ ton may be gained over most any other type of end-dump car, unless it is the tooth bottom type.

While there have been failures with this type of car, and there are probably no mines using them today, there are several cars being tried out. One mine has had 12 of them in operation for four years and reports from there indicate that they are standing up as well or better than the solid end rotary dump type with which the mine is equipped. Another mining company, after trying one out for over a year, has placed an order for 100.

If the automobile can use stub axles, it seems that it should be possible to design a satisfactory stub axle mine car.

With the wide, low swung, large capacity mine car, the question of brakes becomes a problem. It is impossible to sprag these cars and if they must be equipped with brakes, trouble from flat wheels will be greater than with the small car, but even this may be minimized by the use of a cast steel wheel of the proper specifications.

With the through axle end dump car, the tendency is toward smaller wheels in order to lower the bottom and gain capacity. Some mines have gone as far as 12-in. wheels; 12 and 14-in. wheels seem to have a greater tendency to get flat than 16 and 18-in. wheels.

One car manufacturer has developed a brake on the rail. This has been tried out and is said to have proved satisfactory.

If the large capacity car is an important factor in efficiency in a mine where coal is loaded by hand, it is more important in most forms of mechanical loading, unless it is with conveyors where a string of cars may be drawn past the discharge point.

We have cars 14 ft. in length over the bumpers, 7 ft. wide inside and 25 in. in height over the rail with a capacity of 128 cu. ft. water level. A 6-in. crown on this car will give a capacity of a little over 4 tons, and it may be used in a 38-in. bed of coal.

We may, in the near future see cars 20 ft. long mounted on two sets of trucks. A car of this type will go anywhere that a 12-ft. car of the same width on single trucks will go.

In selecting a new mine car, capacity should be given first consideration.

* Chief Engineer, The Koppers Coal Company, Inc.

Large Locomotives in Long Haulage

(*Continued from page* 36)

available, and the delivery of a large tonnage to a central point for preparation and classification.

In general, it is only a matter of building larger and more powerful locomotives, larger mine cars, increased size of rail and better roadbed.

When we come to the trolley we do introduce certain problems that have not been fully developed. Some progress has been made by increasing the size of the trolley to 6/0 and the slider has created a better contact device as compared to the wheel.

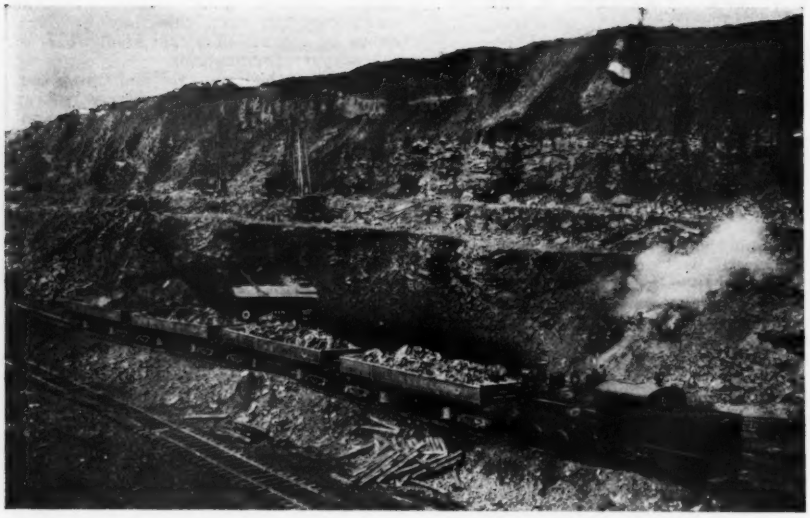
When we consider that many mines are committed to the use of 250 volts or kept within this limit by law, we meet with problems when we attempt to operate locomotives in tandem larger than, say, 20 tons each. Two 30-ton locomotives would require from 3,000 to 4,500 amperes and probably more for short periods of time. This indicates the seriousness with our present type of construction.

There is every reason to believe the builders of locomotives, together with the mine operators, will find a solution, but it does offer a problem for study.

With the use of 500 volts there will still be some difficulty but in a much lesser degree.

Several schemes suggest themselves for the solution of this problem, such as multiple contacts on the trolley, two or more trolley wires or third rail. It may mean catenary construction to support the trolley wire to give a smooth under run for higher speeds.

Such a haulage scheme implies the placing of motor generator sets, rotaries or mercury arc rectifiers at frequent intervals that a relatively uniform voltage may be maintained at all points.



30-yd. cars containing 50 tons of material, 4-car trip, handled on 2½ percent grade by 60-ton geared locomotive

By W. S. Rausch *

ANTHRACITE Stripping and Transportation

STRIP mining is the oldest type of mining in the anthracite region. We began with the famous Quarry mines at Summit Hill where this method was used and only because no other method seemed feasible to the early operators of mining a deposit of the nature found there. Later, horses, plows and scrapers were used and then the original railroad-type steam shovel.

Later on, electrification and traction were applied to new shovel equipment. In the meanwhile, the size of the digging bucket was increased until today, shovels are being built with dippers of 15-cu. yd. water-level capacity.

In the anthracite region, strippings have been and are at the present time an important adjunct to the mining of coal. The economical problem of producing the largest quantity of coal for the least expenditure is the fundamental reason for employment of stripping methods. A higher yield of prepared sizes is obtained by these methods, also a cleaner product is produced, due to better opportunity of separating rough or highly discolored material while loading coal. The removal of clay and other surface wash makes the preparation problem easier at the breaker.

Generally speaking, stripping coal is produced more cheaply and a higher recovery made than by general mining operations, especially since modern equipment has been installed. However, in many cases lessors of coal lands often lower their royalty rates to induce strippings of areas that otherwise would remain unmined. The economical ratio of overburden removed per ton of coal uncovered averages three or four to one, although in recent years with the adoption of modern equipment this ratio has been slightly increased.

The yearly total of anthracite coal stripped exceeds 2,000,000 tons.

Selection of the type of shovel and number to be used depends upon amount and character of work, extent and depth of stripping to be excavated, and disposal problems involved. If hard material is to be encountered or material is to be loaded without blasting, rugged types of shovels are necessary, the size of shovel and capacity of dipper being dependent upon nature of the ground and type of transportation equipment used.

Where soft material is encountered a large dipper can be used, and in sandy soils, dragline excavators will probably be more economical.

For coal loading, small types of shovels are preferable as a cleaner product is obtained, with less waste in the dump and less handling of rock at the breaker.

Electric Versus Steam Shovels

Wherever possible, electric shovels should be installed. Some of the advantages of electric shovels as against steam shovels are:

They are steadier, quieter, quicker, and cleaner. No fuel or water is necessary.

There is no freezing of water lines during winter months. There are no delays due to interrupted water supply.

Smaller operating crews are required because fireman and night watchman are eliminated.

There are no flues to be repaired, an expensive item when irregular working time occurs and fires are pulled frequently with the usual effect upon tubing, especially during winter months.

Electric shovels can be started as soon as the crew arrives. During recent years this has effected large savings to coal companies, where operations have suspended during slack market periods.

Electric dragline excavators are also extensively used. These vary from ½ cu. yd. buckets to machines of the larger type which are equipped with buckets of 6-cu. yd. capacity. Excavators of this type have a wide radius of action and deposit material at considerable distances from the area excavated. Re-casting is often resorted to where the available space on either side of the cut is insufficient to pile all of the excavated material, this being especially necessary when the digging is far below the level on which the dragline stands. Machines of this type often excavate material in cuts filled with water where it would be impracticable to excavate by ordinary shovel methods.

At the Lehigh Navigation Coal Company's Hackelbernie Mammoth vein stripping, a 175-B dragline with a 3½-yd. bucket removed coal to a depth of 125 ft. below level upon which it stood.

With the advent of caterpillar equipped shovels which eliminated delays in moving before and after blasting, strip mining developed mainly into a problem of transportation of excavated overburden and coal; the modern shovels being built of sufficient power and capacity to load rapidly trains made up of large-capacity dump cars.

In the anthracite region in recent years, wherever practicable, standard gage transportation equipment has been adopted, 80-lb. rail being used on track installations. This is necessary, due to the use of 50 or 60-ton locomotives transporting trains of two, three or four 30-yd. side-dump cars on heavy grades. Steel ties are used in conjunction with ordinary wood ties on curves to act as track braces.

At the Summit Hill stripping of this Company, trips of four 30-yd. cars, loaded to 50 tons capacity, are handled from loading point to disposal dump by means of Heisler 60-ton geared locomotives on an ascending grade of 2.6 percent for two miles. The entire distance is covered without any delays due to lack of steam, etc. These cars are of various manufacture, but all are automatic two-way hinged cars of low height, the mechanism permitting dumping to either side. The valve mechanism permits the dumping of an entire train, a single car or any number of cars irrespective of their place in the train. The dumping mechanism is actuated by means of air-operated pistons in steel cylinders.

* Mining Engineer, Lehigh Navigation Coal Company.

320-B shovel loading into standard gauge 30-yd. cars 45 ft. above bottom of stripping cut

The dumping angle of most 30-yd. cars is about 50 degrees, which is steep enough to clean cars of practically all types of overburden material handled from anthracite strippings. The black dirt which overlies veins at their outcrop causes some difficulty in dumping, especially in freezing temperatures.

Drilling

Up to the year 1914, blast holes were drilled with small diameter steam piston drills mounted on tripods. Gradually, 4-in. well drills were introduced; today 6-in. drills are becoming more popular. Electric- or gasoline-driven machines with self-propelled traction are cheaper to operate than the old steam machine and give better blasting condition and results. Our company has in use at its Cranberry stripping five Cyclone 6-in. drills and at Summit Hill 10 Loomis 6-in. drills. The footage averages approximately 25 to 60 ft. per 8-hour day, depending of course, upon the nature of rock and whether it is solid or broken by previous mining.

Holes 5 5/8 in. in diameter are drilled at 12-ft. centers, alternating rows being staggered so that the shortest distance between holes is also about 12 ft. The depth of holes varies with height of cut to be loaded, the average depth being about 35 ft. Second-hand steel pipe is used for casing the well-drill holes through clay or broken ground.

All new drills are being purchased equipped with wire-drilling cable as our records for the year 1929 on a total footage drilled of 120,000 ft. for 6-hemp cable equipped machines indicated a saving of 2½ cents per foot of holes drilled in favor of wire-line device.

Drills are run continuously 24 hours daily, including Sunday.

Considerable difficulty is encountered in drilling, particularly in mined areas, due to broken ground caused by subsidence.

An Armstrong electric bit sharpener is used for all churn-drill bits. Ordinarily, an average of 20 bits is sharpened per 8-hour day, but when extremely hard rock is encountered and the sharpening machine is pushed, 27 bits have been sharpened in 8 hours.

Blasting

The condition and nature of the ground to be blasted is noted when churn drilling is in progress and the amount of powder required to load holes of various depths is calculated.

The following is method employed at our Summit Hill stripping where blasts of 50 to 100 holes are fired, holes with an average depth of 35 ft.

Cordeau is used as a detonator, attached to a 4 by 8-in. dynamite cartridge; 40 percent dynamite is poured into the churn-drill holes from special 12½-lb. bags and the cordeau so placed as to form a continuous detonator throughout the column of dynamite. The average 5 5/8-in. drill hole is capable of receiving a charge of 16 lb. of explosive per foot, and charging is continued until the required amount has been placed. Sand, clay, or other fine material is used for tamping. The heaviest material available should be used to avoid the chimney effect in the shot if a light tamping is used with cordeau. After all holes have been charged and tamped, the cordeau extending from top of holes is connected to trunk line of cordeau and two No. 8 blasting caps are used to detonate the blast.

Well-drillers, helpers and other classes of labor are employed for blast-hole loading. The work is in charge of the chief driller at large strippings, while at the smaller jobs the foreman supervises the loading and blasting.

Narrow-Gage Stripping

Narrow-gage equipment is used mostly for operations where the total yardage is too small to warrant expenditures involved in placing the large standard-gage equipment, where excessive grades prevail, and where operations are in very inaccessible territory. These features occur in the eastern end of the southern anthracite field where extensive folding and submergence of the coal measures has limited stripping areas, thrown outcrops high on the mountainside, and produced a rugged country. Consequently, there are few strippings where large equipment can be used advantageously.

Narrow-gage equipment restricts the size of shovel used to a 2½-yd. dipper type, whereas the smaller shovel on such a job will be of 1-yd. dipper type. Present-day practice is to equip these shovels with caterpillar traction, for ease of moving and for economy in rugged territories.

Locomotives are usually steam driven and range in size from 8 to 20 tons, the latter class being generally used.

Cars for narrow-gage track are of one type, with slight modifications featured by various builders. Capacities of cars in this class vary from 1½ to 10 cu. yd. each, the smaller cars having but two sets of wheels while the larger cars are equipped with double trucks. These cars are termed a lift-gate type—that is, as the car dumps, the gate rises and the material in the car passes out underneath the gate. Some designs have rigid gates; others are hinged and swing freely in the top hinge support; others are equipped with dump rigging that throw the bottom part outward and upward out of reach of the material being dumped. The outstanding disadvantage of all makes is that they are topheavy, the result of an attempt to secure the desired angle for running the material, as well as sufficient size for adequate capacity and strength to withstand the abuse. Few makes of these cars are equipped with air-dumping mechanism, the usual practice being hand dumping.

Most makes are two-way dumps, only a few dump in one direction. The car body is hinged to the center sill of the truck and is held in position by side chains connected to the truck. The chains are equipped with ring and hook to permit dumping.

During the past decade the spreader car has come into wide use for leveling the dump prior to throwing the dump track. Several types are manufactured. These cars are a modified form of the old snow plow. They are built strong and heavy to withstand the abusive service and are weighted to remain on the track while pushing the pile of material over the dump. The main purpose of these cars is to eliminate a prevalent dump delay without additional labor cost. By their use it is possible to operate the dump with a decrease of as many as three or four dump laborers.

With the advent of the spreader car the dump gangs for ordinary dumping were found too small to jack and throw the track; therefore, for economical use of spreader car, a machine to shift tracks had to be developed. The first type with long boom was merely a modified form of the well-known railroad crane, and being steam-propelled and operated were too cumbersome and costly for the ordinary stripping. However, the possibilities were evident and led to the design and the perfection of the gasoline track shifter of today which performs the work efficiently.

Probably 36 in. might well be considered the standard for narrow-gage tracks. The gage to be adopted when purchasing new equipment depends largely on the range of use to which the transportation equipment is to be applied. This is readily amplified in considering a coal-stripping proposition where it is intended to deliver the coal to the preparation plant over existing colliery tracks. There the adoption of the colliery track gage is necessary to avoid a third rail system or the building of an entirely new track from the stripping to the plant.

Other added features of the wisdom of this selection are the facility with which it furnishes supplies, changes and repairs

to equipment, and many others of a similar nature.

Weight of rail depends largely on size of equipment used, in general the weights vary from 30 to 60 lb. per yard. Better practice is to use the heavier weights of rail to reduce track maintenance costs. This feature is often overlooked by stripping operators.

To obtain maximum production, it is obvious that grades of all tracks should be as flat as possible; 4 percent should be the heaviest grade used. It is possible to operate on 6 percent grades, but these have proved to be extremely inefficient because of decreased production and higher costs of the extra motive power required. Tracks placed on heavy grades are hard to maintain and therefore are a constant source of wrecks.

The number of turnouts depends upon the production to be handled. The tendency is to use too few, as is noticeable at many operations, costly delays of the shovel are caused by lack of cars due to delays in transportation. Always, the answer to large production is adequate transportation.

Each shovel should have its individual dump and dump crew. Spreader car and track shifter should be interchangeable on the various dumps. If large shovels are used and a large production is to be handled, a spare dump with a few extra laborers in attendance is never amiss. For earthy materials a dump height of 40 ft. is ideal, rock materials permit the use of higher dumps with little added trouble. The dump should be sufficiently large to handle at the least the shovel's production for one shift. Then, with a small amount of overtime work the dump is always ready for use.

Exceptionally long dumps are not desirable, especially if they provide dumping space for more than two or three days. The objection is that a large part of the dump track will not receive the proper attendance—that is, while the end is being filled the back will settle, and conversely. The economical length is limited to a distance where the filling and throwing continually maintain the dump track at the proper elevation and in good alinement, thus having the filling balance the settlement that always occurs.

To blast material for loading in small cars, more drilling and explosives are naturally required than for large cars. If this feature is neglected smaller production will result and losses will be much larger than any apparent saving to be had by doing less drilling and using less explosives.

To facilitate dumping, the cars should be loaded heavy on the dumping side, a feature that works well when the cars are new and not likely to dump enroute to the bank. Old, worn cars are sometimes difficult to load this way.

Loading delay at the shovel is caused when the dipper is too large for the car in use; if the runner digs the fraction of a dipper full, which is usually required to complete loading of the car, the shovel is being operated inefficiently; if he obtains a full dipper to top off the car a spill results and must be cleaned before the trip can be moved. The feature just cited is an argument against the use of cars of small capacity. Shovel runners should also be cautioned against loading too large boulders, any time saved thus at the shovel is lost many times over in transportation or on the dump. The better practice is to throw the large boulder aside and blast it for loading in the next cut.

Common practice is to man each locomotive with an engine man only. He is required to perform all work necessary to move the trip. His work is supplemented by the employment of switchman or automatic switches at turnouts. If cutting and shifting of cars is necessary, such as in the handling of mine cars, then a patcher is furnished. The trip handled varies from 5 to 12 cars, depending on grades. A maximum production obtained in 9 hours from a shovel with a 2½-yd. dipper was 1,500 cu. yds., no delays having occurred. The maximum averages for a shovel of this size, working under favorable conditions, are 24,000 cu. yds. of clay and 12,000 cu. yds. of hard rock per month of 25 8-hour days.

The answer to the transportation problem at modern strippings is, therefore, mainly one of using the larger type cars, either narrow or standard gage, with engines of sufficient power to pull heavy loads at average speeds rather than small loads at high speeds. In the selection of the type of locomotive to be used an important consideration is its ability to withstand rough usage over uneven tracks and able to negotiate the heavy grades that are invariably used in stripping layouts.

Power in Mechanical Mining (*Continued from page* 33)

capacity, while when we take one-tenth of that, or 1,000 connected horsepower, we need 40 percent in generating capacity.

There was one statement in this paper that I believe might lead to some trouble; that is, if we go to more than one generating unit, or substation unit, we require increased total capacity. We have found conditions where with one station, we will say of 600 kw., by splitting that station up into two 300 kw. units, properly spaced, the demand on the station is actually decreased. It was in the combined stations that we had a reduction in the losses of the distributing circuits.

I believe it is well to keep that in mind, that splitting up stations does not necessarily mean much, if any, increase in the total installed capacity.

Those are about the only points that I have on this paper.

F. L. Stone, *General Electric Company:*

Mr. Lee's paper opens up a subject, the study of which will, I believe, result in better returns per kilowatt of energy used.

The copper losses in mine transmission has already been given a great deal of thought by mining engineers, and its evils are fairly well understood by the majority of operators. Notwithstanding all that has been written and said regarding copper losses, my own experience leads me to believe that many miners are wasting a very appreciable amount of money every day from this cause.

The evil shows itself in two ways: First, in the dollars and cents wasted in voltage drop in the feeders, and, second, in the loss of tonnage due to reduction in speed of all direct-current motors.

As a rough example, which may be slightly exaggerated for the average case, let us assume a mine producing 4,000 tons of coal per day. If completely mechanized and electrified, the power consumed would be in the vicinity of 4 kw. hrs. per ton of 16,000 kw. hrs. per day. Assuming an average loss of 20 percent in the feeders, this would mean 3,200 kw. hrs. per day, and at 1 cent per kw. hr., $32 per day. By reducing this loss to 10 percent, a saving of $16 per day would result. This, for 300 days per year, would amount to $4,800. This saving alone would pay for approximately 4 miles of 500,000 circular mil feeder.

Twenty percent line loss would mean quite a reduction in tonnage, the amount of the reduction depending somewhat on local conditions. In a mine otherwise efficiently operated, the loss in tonnage might easily amount to 5 percent or, in the case of the 4,000-ton mine, 200 tons per day. Any thoughtful operator can estimate quickly what such a loss in tonnage would mean to him in his profit and loss account, bearing in mind that the addition of 200 tons could be obtained without any additional labor or overhead.

It is, of course, obvious that there will come a time when it is no longer economical to install copper, as the interest on the copper investment may easily exceed the saving resulting therefrom. The next move is to install a substation either underground or on the surface, as close to the load center as practicable. This substation can be of the automatic type, which has long since passed the experimental stage, and when installed will insure good voltage for a considerable period of time. Should the mine be in a developmental stage and the load center be changing with a fair degree of rapidity, it would seem logical to install a portable automatic substation, which is also a decidedly practical and completely developed device. This portable station can be moved around the mine on the mine tracks to such points as are indicated by the load conditions, it being only necessary to supply the high voltage a. c. current to the set.

The various mechanical devices for loading, cutting, pumping, etc., are usually equipped with Bureau of Mines approved electrical apparatus, or at least they can be so equipped if desired. The manufacturers have developed apparatus which has met the approval of the Bureau of Mines and this is available for practically all types of machines. There seems, however, to be no standard code of any description for the guidance of the operator in the wiring to these machines. In other words, there seems to be a missing link in the safety program. I have seen approved motors and control working at the face so wired as to present a very definite hazard.

It would seem to me to be quite advisable to have some very general rules and suggestions drawn up by mine operators or their representatives which would embody the best practices along this line.

WILDWOOD — A 100 % Mechanized Mine

By W. P. Vance *

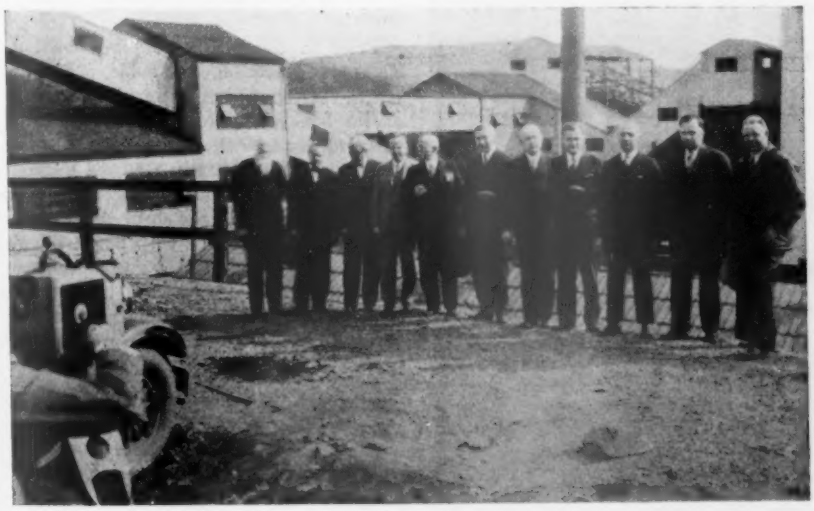
WILDWOOD MINE is located on the main line of the Baltimore and Ohio Railway about 12 miles north of Pittsburgh. The mine operates in the Thick Freeport bed, which at this property average about 8 ft. in height. The seam in the mine consists of two parts, a top bench and a lower, which are separated by 12-in. to 14-in. of bone and boney; cover averaged 350 ft. with a black slate top immediately over the coal seam and a hard fire clay bottom.

In planning and developing this property, we have kept in mind at all times that this plant should not merely mine but should mill or refine its product; that the plant should be capable of producing a coal which would meet the requirements of various power plants, for metallurgical purposes, as well as producing a coal suitable for steam and domestic purposes; that it should be equipped in such a manner that coal could be produced and refined in the most economical manner, consistent with the production of a quality product; that the equipment and procedure should be such that at all times a positive control could be had over all operations in order to produce a product which would be uniform as to size and quality. We also desire to follow all safety practices, in so far as possible, as recommended by the United States Bureau of Mines, American Mining Congress, and the Pennsylvania State Department of Mines.

In employing our men we have considered that these men are not merely miners, as spoken of in the ordinary usage of the term, but are for the most part machine operators, mechanics and electricians. All of our men pass a very rigid preemployment medical examination, and we have a form filled out which gives us a very complete history of the man himself and his services prior to coming to our mine.

The first operation in the day's work is testing by the fire boss, who inspects the mine for gas, for bad roof, or other hazards which might endanger the lives of the men or damage the equipment. In fact, it is a practice to inspect each working place before men or machines are allowed to enter for the performance of any of their duties. When the men come to work they first enter the wash house, where they change from their street to mining clothes, which are warm and dry for them upon their arrival. They then pass through the lamp house, where approved battery lamps are issued and where they punch the time clocks. By the use of these clocks an accurate record is kept of each employe. When leaving the mine after their shift, in addition to punching the time clock they report on another clock the injuries which they may have received during the shift. In traveling to the face the men travel a separate manway from the opening to the working face, and are not at any time exposed to haulage or other mechanical hazards.

* Chief Engineer and General Superintendent, Butler Consolidated Coal Co.

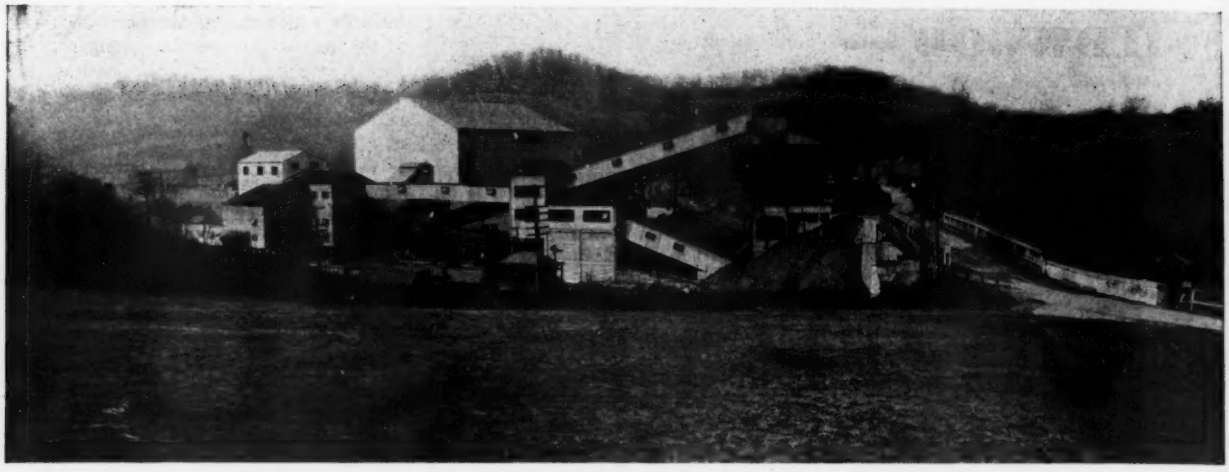


Directors and Operating Officials. Left to right—Z. P. Lauffer, director; J. H. Fletcher, of A. & G.; S. Sherwin, vice president; C. A. Wilder, assistant secretary and treasurer; Geo. C. Stewart, director; T. W. Phillips, Jr., chairman of board; Judge Aaron E. Reiber, director; R. E. Sprenkle, secretary and treasurer; C. F. Hosford, Jr., president; W. P. Vance, chief engineer and general superintendent; E. J. Weimer, superintendent, Wildwood Mine.

Face Preparation

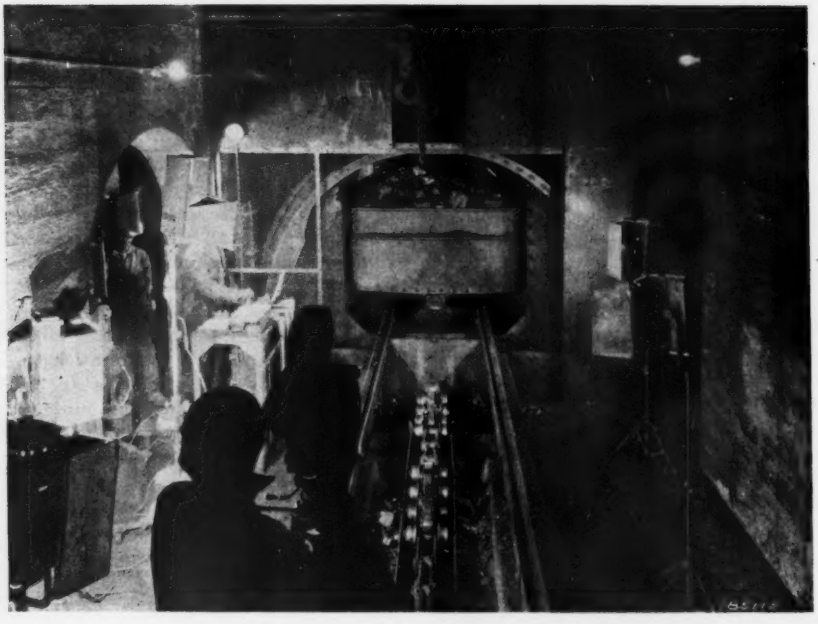
Once arrived at their respective sections the men immediately proceed with their duties in the work at the face. A definite cycle is followed, the first operation of which is the setting of sights by the engineers, as all working faces are driven according to a predetermined plan. After this the trackmen come in and place sections of track on which the cutting, drilling, and loading machines work. These sections are all of uniform length, as we have found that this is an aid toward obtaining a maximum uniform depth of cut by the cutters. The track is levelled up with much greater care than is necessary in the ordinary non-mechanical operation, for during the cycle of operations we will have working on this track machines weighing as much as 32 tons, which subject it to very great strain.

The drilling is done by a track-mounted drill, self-propelling, of the rotary type, with automatic feed and reverse. Exceptional care is taken in the locating and drilling of these holes, as we have found that this is very essential to proper shooting of the coal and preparation for the loading operation to follow. The machine is equipped with an 8 hp. continuous rated, permissible type motor, giving it sufficient capacity for continuous operations. This drill, as well as all other equipment operating at the face, is of the government approved, permissible type. At the present time these drills are drilling over one hundred 9-ft. holes per shift, using from four to eight holes for each working face. In this connection, we have found that we get much better preparation by increasing the number of holes and decreasing the amount of explosive used per hole. We have also increased the length of our



General View of Plant

Retail bins at right, office behind them and roof of shops, wash house, etc., showing to their left. Belt conveyor structures passing through hoist house in center. Cleaning plant is large building to left center. Tipple and clean coal bins at left.



All set to take a movie of the rotary dump

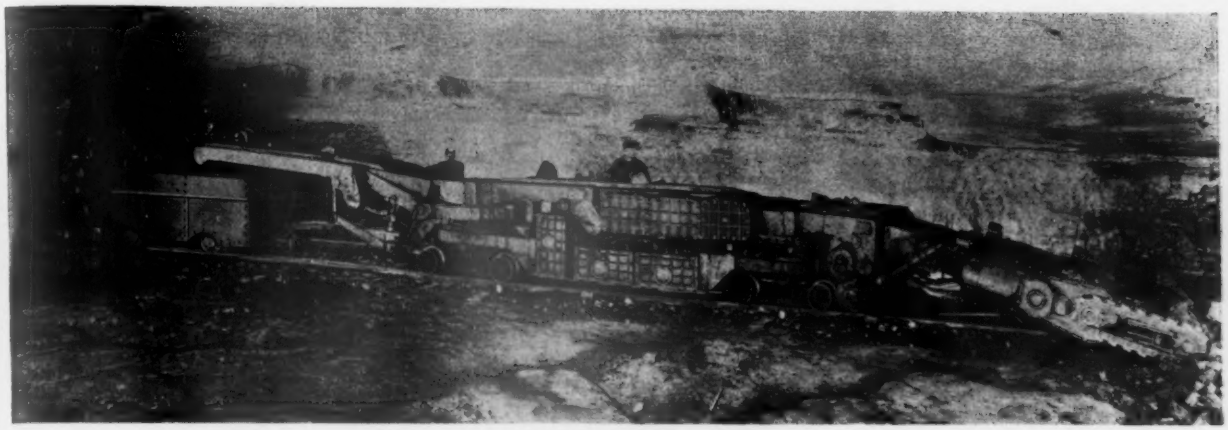
A fall of coal showing results of proper cutting, shearing, drilling and shooting

thread bar in order that we may obviate the necessity for changing drills during the drilling operation. We find that this has increased the speed of drilling considerably.

When the holes are drilled, the cutting machine moves into the face. At the present time we are using the Oldroyd universal cutter, as we felt that it was absolutely essential that all of our cutting operations be done by one machine in order to keep the number of machines operating on the truck at the face at a minimum. This machine is capable of cutting from a place 6 in. under the rail, to a place some 7½ ft. above the rail, and can also shear in any position between points 4½ ft. to each side of the center.

Prior to the placing of the cleaning plant in operation, we made our first cut in the top bench of impurity, known as the boney. The cutter bar was then dropped down to the bone, and a second cut taken which entirely removed all impurities from the seam. The cutter bar was then turned and the shear cut placed. This last cut, together with our drilling and shooting, has enabled us to produce a much higher percentage of lump than is usually obtained from narrow workings. At the present time we are cutting 14 faces per shift, each face being cut three times the width, averaging 15 ft., and the depth of cut being 9 ft.

We have found that in order to secure the best preparation it is necessary that the shots be placed with great care, and after much experimental work we have finally located our holes and the charge in such a manner that we feel we are obtaining a maximum amount of lump coal. These shots are fired with a mag-



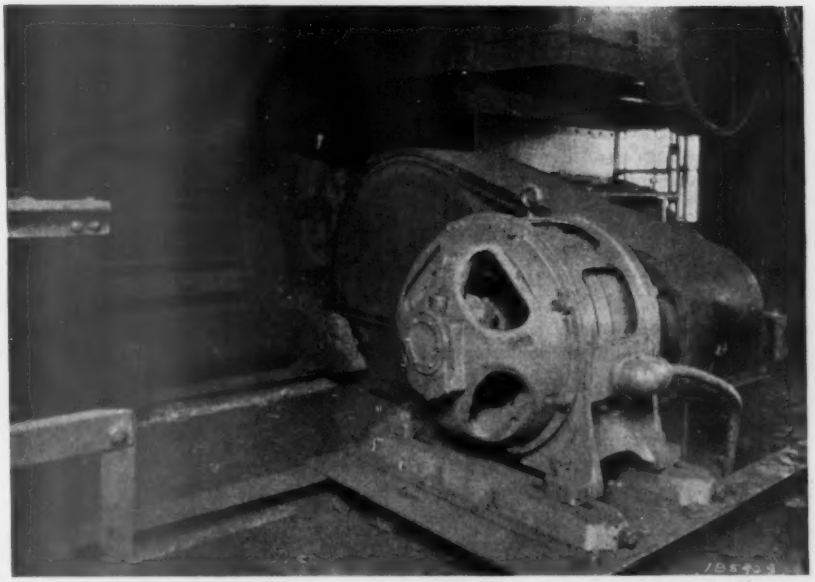
Oldroyd Loading Machine
Equipped with 13 Government approved explosion proof motors and control. Capable of loading 5 tons in 1¼ minutes. Machine is 48 ft. long and weighs over 30 tons

neto one at a time, the bottom holes being shot first. All caps are kept short circuited until connected with the magneto. We have found one principal advantage of correct placing and shooting of the charges to be a straight rib line without uneven bumps, which if left would delay the loading operation considerably. At the time the movie was taken of the operation of the Wildwood mine we developed some very interesting shots, the pictures of the shooting being particularly interesting. It was necessary in taking these pictures to determine just how close to the face the lamps and motion-picture camera could be placed without exposing them to injury. In taking these pictures special reflectors were used, in each reflector there being placed two 1,500 watt mazda lamps. Thirty-five of these reflectors were used, giving a total illumination of approximately one-quarter million candle power on the face. The accompanying photograph showing a shot of coal prepared ready for the loading machine indicates the excellent results which are obtained by the proper drilling, cutting, and shooting of the face.

Front end of Oldroyd loading machine

Loading

At the present time we are using two types of loading machines, the Joy and the Oldroyd. The Oldroyd is the larger of the two, our first machine being 57 ft. in length and weighing approximately 32 tons. This machine is equipped with 13 Government approved, permissible type motors. All control equipment is mounted on the sides of the machine in order to facilitate inspection and repairs. The machine consists of three main parts: the front, or digging boom; the center portion of the machine mounted on the trucks; and the rear, or discharge

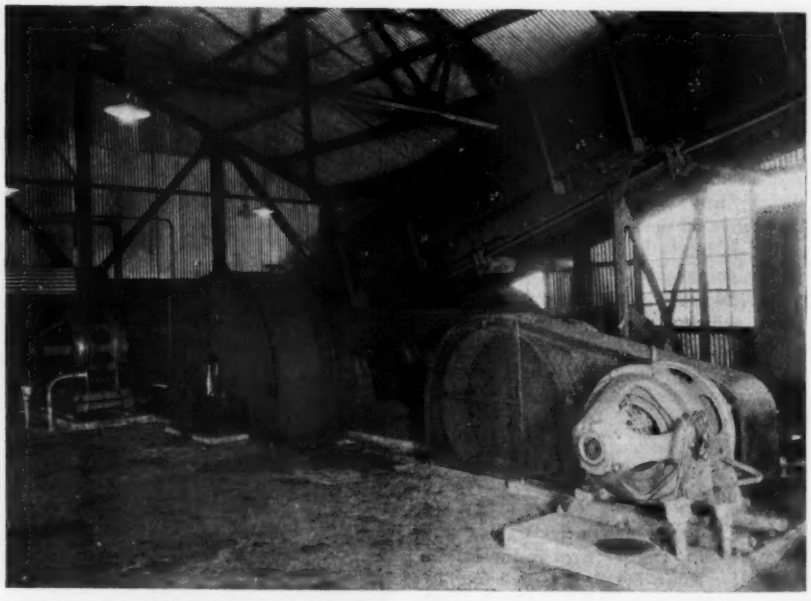


Crushers installed in tipple to crush all or any part of output to any desired size

boom. Both the front and rear booms may be raised or lowered and swung to either side. All movements of the machine are direct motor movements, no clutches being required in the operation of this machine. At the present time the machines are loading approximately 500 tons per shift. The machine is operated by two men; one operating the main part and front of the machine, the other merely operating the stop switches on the rear, or loading conveyor. By means of four propelling motors, attached one to each of the axles, the machine is driven into the coal up to the slipping point of the wheels. The rotary motion of the dipper, which is located at the front, rolls the coal back into the first conveyor. The machine has sufficient power to enable it to shake down and lower any shots which may be standing and not properly rolled out. Although the machine operator is located some 20 ft. from the face, and presumably out of the way of any dangers of bad roof, the machines are stopped occasionally in order to permit the operator to test the roof.

In all of these operations at the face, as well as all operations throughout the mine and top plant, each section foreman, machine operator, repair man, assistant foreman, or any man being responsible for any operation, is required to keep a daily log of the operation of his machine or the work which he has performed. At two-hour intervals the performance of each section is phoned to the despatcher, who relays this information on to the main office. In this manner a constant contact is established between the operating officials and the men working at the face, and difficulties of various kinds may be detected and removed immediately. In addition to these reports, time studies are constantly being made of all operations and all machines. These studies are even kept on the track-laying crews, and detailed reports are made each day as the result of these time studies. These reports and studies are very carefully analyzed in order that corrections may be made of any faulty practice developed. We feel that these time studies together with the reports of the various units are of very great value and importance to us, and we attribute to these a great portion of any success we may have had in the operation of our mechanical mine.

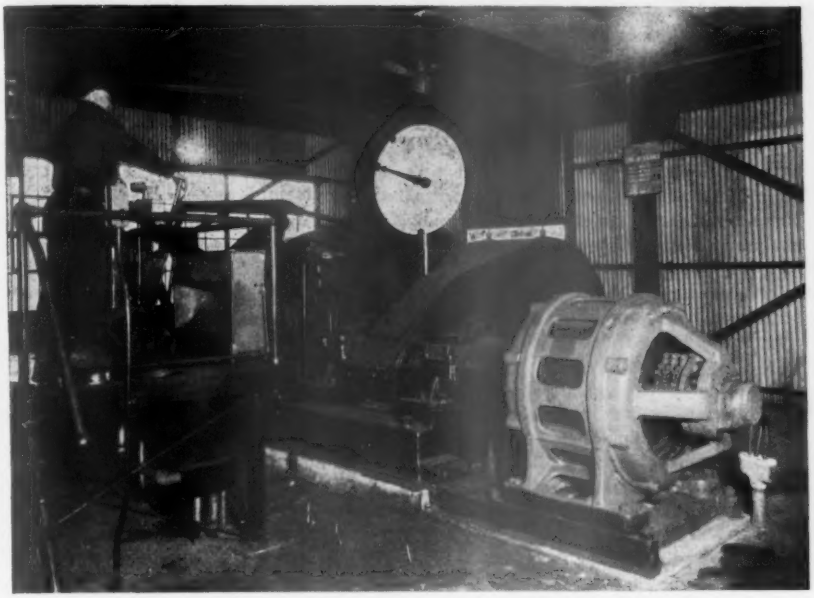
Left, primary 300-ton Peale-Davis table. Center, clean coal conveyors from cleaning plant to clean coal bins in tipple. Right, secondary 300-ton Peale-Davis table.



Duplex motor drive on 54-in. 1,750-ft. belt conveyor from mine. Motor at left 225 hp. At right, 75 hp. adjusted to automatically operate at different speeds taking care of belt stretch.

Transportation System

We have found in the operation of the loading machines that a comparatively small percentage of its time is actually spent in loading coal. Our main problem is one of transportation and removing the coal from the machine. In order to facilitate this an elaborate system of dispatching has been devised which is functioning very efficiently at the present time. Gathering is done by means of eight-ton battery locomotives and eight-ton combination trolley and cable reel locomotives equipped with explosion proof motors and control. Our haulage is kept separate, the loads being transported to the bottom on an entry equipped with 60-pound rail. It might be well to note here that in spite of the fact that we were designing a mechanical mine, we were very fortunate in being



Hoist used in removing and furnishing equipment and supplies to mine

able to locate out mine opening at such a point that we were able to take advantage of grades in favor of the loads, and natural drainage in the mining of approximately 70 percent of our available tonnage. The empty track is entirely separate from the load track and is equipped with 40-pound rail. Manganese switches and frogs are used at all main junction points and 6-0 trolley wires with the latest type hangar and switching equipment.

Power at the Face

In mechanical mining such as we are doing we have found that our power load is very highly concentrated in the working sections of the mine. For this reason we have developed in connection with the General Electric Company 300-kw. portable motor generator sets in furnishing power to the working faces in the different sections. These sets receive their power through submarine armoured cable which is buried in the bottom in a trench cut beside the track. This trench has been cut with the cutting machines, the cutter bar being turned to the shearing position and the machine trammed along the track cutting the trench as it goes. The sets are housed in cross cuts in the various sections of the mine and are placed in portable houses built of steel and transite. Power from these sets is fed to the working face in the ordinary method. These sets are built with motor generator set mounted on the one truck, the a. c. panel on another, and the d. c. panel on a third so that they may be disconnected, moved to a new location, and operating again in less than a shift. These have been of great service to us in maintaining uniform and high voltage at our various equipment and have reduced the number of break-downs and burn-outs due to low voltage to a very great extent.

The mine is thoroughly rock-dusted, using a high pressure, Government approved rock dusting machine which receives its power from one of the storage battery locomotives. At the bottom the coal is dumped by means of a rotary dump which is fully automatic with the exception of the start and stop. Dust from the rotary dump is drawn off through the bottom of the enclosure by means of a permissible blower which dispatches this dust through a pipe to the surface. The dumping chamber is equipped with curved side and discharge plate built in such a manner that as the car is turned over the coal slides into the bin rather than being thrown or dropped, thus reducing breakage. The rotary dump pauses for a few seconds in the vertical position in order to allow the car to clear, then accelerates and returns to normal position. The cars hold about 5½ tons machine loaded and are equipped with roller bearings, spring boxings, and spring swivel couplings. They are also built with a top section of 1 ft., being removable without destroying the car in case low coal is being mined. Cars are equipped with brakes operating on two wheels, although provision is made to add brakes to the other two wheels if found necessary. One man controls all operations at the dump and also the feeding apparatus from the storage bins to the belt. Ample provision on the bottom is made for the storage of loads and bins are also provided at the dump as a method of equalizing production with belt capacity.

A Major Feature

One main feature of the entire Wildwood plant are the provisions which have been made where the different operations merge into one another for the storage of coal which provides that in case of temporary stopping of any one operation the plant can still function in spite of the delay. Large storage bins for raw coal are provided between the tipple and the cleaning plant and other large bins for storage of cleaned coal are provided between the cleaning plant and the loading plant. On the bottom the cars are handled into and out of the rotary dump by an automatic car haul equipped with hydraulic brakes which operate in either direction. Provision is made to store either coal or slate at the bottom, a fly valve being used to throw the coal from the dump into either bin.

The conveyor belt is 54 in. wide, 12-ply, 36-oz. duck, rubber covered, and was shipped to the mine in two sections. Two ends were vulcanized together, the other two ends being fastened with a metal clamp. It was run this way for a considerable length of time until it was felt that approximately all of the stretch was out of the belt, and then the remaining two ends were vulcanized, making it an endless belt approximately 1,800 ft. long. The total lift from the belt feeders on the bottom to the discharge point on the tipple is 210 ft. The belt drive is located between the tipple and the mouth of the slope on the surface. It is a duplex drive, one motor rated 225 hp., the other 75 hp., and adjusted to automatically operate at different speeds, thus taking care of the belt stretch. This drive, as well as the majority of others throughout the plant, are of the Texrope type. The belt has a normal capacity of 750 tons per hour, although after operating it for some time we feel that it will safely handle at least 30 percent more than this. From the main belt the coal discharges onto the screens where it is separated into plus 4-in. lump and a minus 4-in., which is passed over to the cleaning plant. The 4-in. lump coal is passed over reciprocating picking tables where it is cleaned and inspected and then passes to the mixing conveyor, or the loading booms, and thence into the cars or retail coal bins.

Cleaning the Coal

The tipple is equipped with two large crushers capable of crushing all or any part of the mine production to any desired size. It is also equipped with mixing conveyors which enable all of the various sizes and coals of different analyses to be mixed in any proportion.

The minus 4-in. is passed through the cleaning plant, in which are installed three Peale Davis Pneumo Gravity Air Cleaning Tables which have a capacity of over 300 tons per hour. The raw coal goes over the first table which separates it into three parts: one being a very low ash and low sulphur product, another the intermediate, and the third the refuse. The intermediate coal is crushed and together with the refuse from the picking table is passed over the second table where a second cut is made. From this point the intermediates again travel on to the third table where a final rejection of the refuse is made. In cleaning the Freeport coal, where the difference in specific gravity between the coal and the boney is slight, we have found that the operation of the three tables gives us an even better result than is obtained from the passing of many other seams of coal over the ordinary installation of one or two tables. All motors in this plant are equipped with explosion proof collector rings as a safety precaution. The air is furnished by three large fans of the high torque full voltage starting synchronous type, which enables us to correct our high power factor. The air is operated in a closed circuit system, being re-circulated after the dust has been settled out and removed. The tables are approximately 65 ft. long and 14 ft. wide, weighing some 35 tons, and carrying a load of approximately 40 tons of coal. These tables are driven by two 30-hp. motors at a speed of 170 revolutions per minute at a stroke of 2¼ in. This cleaning plant is one of the principal operations of the Wildwood plant in that it is here that the coal is refined to meet the various specifications necessary to produce coal for the various purposes for which it is used. From the cleaning plant the coal travels over two belts to a system of storage bins in the main tipple. A screening plant is located over these storage bins and between the storage bins and the loading booms another battery of screens is located. These enable us to produce accurately sized coal in any of the numerous sizes which the present selective market demands. It is also possible through these bins to analyze the operation of the cleaning plant and the tipple and to furnish coal which will be uniform in analysis from day to day. In fact, it is possible to furnish a guaranteed analysis with any shipments which are made, as the sampling and analyzing of these samples is carried on in a very well equipped sampling room and laboratory. These operations are performed on a production basis, a definite routine being followed which enables us to keep a constant check on the product as it moves through the plant. Loading into cars is done by means of drag type loading booms which operate from the mixing conveyors extending throughout the entire cleaning plant and tipple. Coal of various sizes in different proportions and analyses is very readily and efficiently loaded.

Avoiding Delays

In providing shops, store room, and other facilities for properly maintaining the various equipment used at this plant, it was kept in mind that equipment would be in operation the greater portion of the time and that delays must not be tolerated. For this reason the shops are very completely equipped to handle all types of mechanical and electrical repairs. A large corps of specially trained electricians and mechanics make a special inspection of all equipment between shifts. Accurate records of parts and labor are kept together with detailed reports of all inspections which are made.

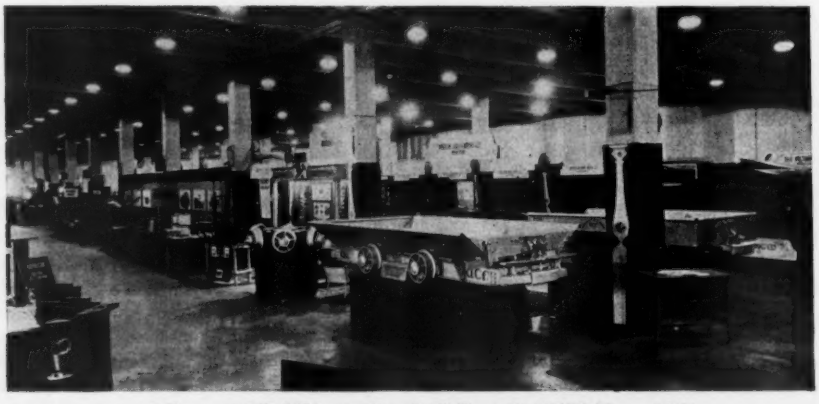
Accident Prevention

In our safety work we have been guided by the recommendations of the United States Bureau of Mines, American Mining Congress, and the State Department of Mines. All men are trained in first-aid work, and numerous crews are trained in mine rescue. A large assembly hall is equipped with a motion-picture machine and all facilities for the training of the men. Very complete first-aid and mine-rescue equipment is kept on hand immediately available at any time that it might be needed. Meetings of various groups of men are held during the day and evening during the week, when instructions on safe practices and efficient operation of the various types of equipment is given.

In the planning, development, and operation of Wildwood we have endeavored as much as possible to get away from the conception of a mine as being a number of various units and operations remotely related to each other. We, of course, emphasize the importance of each operation, but feel that more important is the relation of each operation to the one preceding and following, as an uninterrupted flow of our product must be maintained from the face through all of these operations to its ultimate destination in the railroad car.

After several years of planning, ground was broken on July 5, 1928, the first coal removed the latter part of December, 1928, and at the present time the full plant is functioning. We feel that we have initiated a system of mining and refining of coal which will meet the specifications of the various plants and processes where coal is used, and that a product accurate in size and uniform in quality can be delivered at all times.

In speaking of those who have been responsible for the mine, I feel that special mention should be made of the services of Mr. T. W. Phillips, chairman of the board; Mr. C. F. Hosford, president; Mr. R. E. Sprenkle, secretary and treasurer; and Mr. E. J. Weimer, superintendent; and in the Allen and Garcia organization, Mr. J. H. Fletcher and Mr. Harry Hibley; and of the Westinghouse Electric and Manufacturing Co. organization, Mr. W. D. Turnbull and Mr. Paul Jordan; all of whom, together with many others, have given unsparingly of their time, thought, and labor toward the development and operation of the Wildwood plant.



A Group of Exhibits in South Hall at the 1930 Exposition

VOCATIONAL TRAINING among Coal-Mine Employees

. . . especially by NIGHT MINING CLASSES and SUMMER SHORT COURSES . . . . . .

By J. J. Rutledge *

IT IS necessary that mine foremen and fire bosses receive training in mine safety and mine management. Not only should the mine foremen, superintendents and firebosses have had practical experience at the working face but they should, in addition to this experience, receive training in the proper way to handle labor, how to meet adverse mining conditions, and how to operate a coal mine safely and efficiently.

The large public service corporations take young men, many of them just out of technical schools, and train them in their business, especially in the methods and ways the companies do their work and in the preparation and submission of reports, of costs of operation and of maintenance.

It is almost impossible for a middle-aged man to obtain employment with such corporations, for they require that their men be trained in their own way and they prefer to get these men at an early age.

Night mining classes are being conducted at the present time, so far as the writer's knowledge extends, in the coal fields of Pennsylvania, West Virginia, Maryland and Ohio. There may be, and doubtless are, other states where work of this sort is now being carried on but of which work the writer is not familiar. Night mining classes have also been conducted, in past years in Kansas, Oklahoma, Illinois, and Iowa.

The Maryland night class work was begun September 10, 1923. During the first examination of mine foremen and firebosses, which was held at Frostburg in January, 1923, there arose on the part of some of the candidates a demand for instruction in the elements of coal mining in order that they might be able to pass the State Mine Examining Board's examinations for mine foremen and fireboss certificates of competency. The first certified mine foreman and fireboss law in Maryland became effective October 1, 1922.

The writer had become more or less familiar with night mining classes as conducted in the bituminous coal fields of western Pennsylvania, in the anthracite fields of northeastern Pennsylvania, in West Virginia, Illinois, Kansas, and Oklahoma, and had observed the progress of the work in these different states. At the outset Maryland followed, as closely as possible, the same work as carried out in West Virginia. An arrangement was made for matching the funds expended by the state of Maryland by funds supplied by the Federal Board for Vocational Education, and, for the first year, the salary of the instructor was paid from funds of the Maryland Bureau of Mines. After that the salary of the vocational mining instructor was carried in the budget of the University of Maryland and is there carried at the present time, the work being under the auspices of the University of Maryland, the county boards of education of Allegheny and Garrett Counties and the Maryland Bureau of Mines.

An instructor, who, when he reported for duty, proved to be a resident of Maryland, was obtained from the West Virginia staff. This instructor, L. C. Hutson, Kitzmiller, Md., began the work and is entitled to great credit for the success of the work. Later, an associate instructor, R. C. Fleming, a graduate in mining engineering from the University of Illinois, was appointed. He left the work in September, 1928, and in January, 1929, Robert D. Ewing was employed as assistant vocational mining instructor.

From the start there were five classes per week conducted by each instructor, instruction being given on every week-night except Saturday. All of these classes have met in the evening. At the present time there are 10 night mining classes being conducted, five by each instructor, one series of classes being in the Upper Potomac region and the other in the George's Creek area.

It was early realized that there would be necessity for advanced training, and in 1927-1928 two classes in what has since been called "mine management" were started. One of these classes is in operation at the present time. The subjects taught in these mine management classes are such as haulage, timbering, use of explosives, and also the personal element in mine management.

Fees

For the first year or two the fees were $5 for the night classes, which was really an enrollment fee to be returned to the student at the end of the course if he had attended 80 percent of the classes. This was later reduced to $1 and made non-returnable. The enrollment fee for the short course is $10 and is non-returnable.

Instruction

All of the instruction in the night mining classes is by the lecture method and by the use of home-work books, or written questions and answers. The students answer the questions asked them in their note-books, these note-books being corrected each week by the instructors.

Subjects Taught in the Night Classes

The subjects taught in the night classes are: Coal-Mine Gases, Safety Lamps, Coal-Mine Ventilation, Mining Arithmetic, Map Reading, Maryland Mining Law.

The text-books used are the following (issued by the Federal Board for Vocational Education, Washington, D. C.):

Bulletin 39—Trade and Industrial Series No. 9, Coal Mine Gases (October, 1919).

Bulletin 42—Trade and Industrial Series No. 12, Safety Lamps, including Flame Safety Lamps and Approved Electric Lamps (November, 1919).

Bulletin 41—Trade and Industrial Series No. 11, Coal Mine Ventilation (November, 1919).

In addition to these, a series of ideal mine maps have been developed for use in teaching map reading and mine ventilation.

An instruction pamphlet entitled "Electricity Applied to Coal Mining," edited by a prominent electrical engineer, who has specialized in electrical coal mining machinery, has been prepared as a result of the experience gained in the six years' instruction.

A similar pamphlet covering the subject, "Method of Working Coal," is about two-thirds complete.

The enrollment and attendance has been as follows:

Year	Enrollment	Average weekly attendance	Percentage attendance
1923-1924	315	160	50
1924-1925	236	125	52
1925-1926	281	126	44
1926-1927	230	126	54
1927-1928	250	146	58
1928-1929	286	146	51
1929-1930	339	161	47
Total and average	1,937	141	50

To date, 1,101 individuals have enrolled in the night mining classes and summer schools. On the basis of 3,600 mine employes in Maryland, with no allowance for labor turnover, this would mean that 30.5 percent of the mine employes of the state have received instruction.

It may be interesting to note that of the total enrollment of 1,937 men, 836 of them enrolled for a second year of instruction, and many of them have attended classes for seven years.

Promotions

There have been a great many promotions as a result of the class work. Sixty-four students received an aggregate total annual increase in salaries of $54,000 as a direct result of the work in the classes and summer short courses.

Promising Students

Several of the young students in the classes have shown mental ability of the highest order and intellectually they would reflect credit as members of the freshman class of any college or univer-

* Chief Mine Engineer, Maryland State Bureau of Mines.

sity that might admit them. A few have taken employment with mining companies in other states and they are uniformly doing good work in their new fields.

Age of Students

The students have ranged in age from 16 to 70 years, though the greater number range in age from 30 to 40 years.

The technical knowledge gained in night classes and summer short courses is applied at once in practice by the student in his daily work in and about the mines and becomes at once an asset upon which he realizes immediately in increased wages and in promotions. Moreover, the mining company also receives benefits from the student in increased safety and efficiency.

Summer Short Course in Mining

Each summer since the work was begun there has been conducted a six-weeks short course in which intensive training was given mine employes, most of whom were working in the neighboring mines.

The subjects taught in past years have been: Methods of Mining Coal, Mathematics, Explosives, Drainage and Pumping, Mine Ventilation, Mine Fires and Explosions, Safety Lamps, Electricity in Mines, Mine Gases, Mine Haulage, Geology of Coal, Mechanical Drawing, Map Reading, Maryland Mining Law, Instruction in First-Aid and Mine-Rescue Work.

The hours of instruction have been from 8 a. m. to 12 m., and from 1 p. m. to 4 p. m. In some years nearly all of the students have been men who were employed on the night shift and hence could attend the classes only in the forenoon. Under these adverse conditions some of the men have done very fair work.

The summer school enrollment has been as follows:

Year	Enrollment
1924	32
1925	21
1926	19
1927	19
1928	6
1929	11
Total	108

Of the above total number of students, 73 now hold Certificates of Competency for Mine Foreman and Fireboss.

The benefits of an intensive course in mining, such as the summer school affords, should have a considerable effect for the betterment of management of the coal mines of the state.

These night classes, especially the summer-short courses, push to the front and to the attention of mine officials and operators promising, likely or ambitious mine employes. This is especially true of the younger and more ambitious men.

One tendency of the night classes is to make the men more thrifty and industrious, particularly as they change their points of view regarding labor conditions in the mines, although this, of course, is a matter that can only be indicated and can not be discussed in a paper of this kind.

Some of the most promising men that come to the night classes and short courses are middle-aged men, or men approaching middle age, who have, so to speak, found themselves and have realized rather late in life that it is necessary for them to obtain some technical training in mining if they are to obtain promotion, and some of these make the best students in the classes.

The District Mine Inspectors have ably assisted in the work and one of them, during the first three years of the work, taught Maryland Mining Law and first-aid and mine rescue during summer courses.

About 97 percent of the students are native-born and all are English-speaking. The average previous education received by the students before they enrolled in the night classes or summer schools was from 3½ to 4 years. Many of the students went into the mines at an early age.

The work has not been at all easy; to keep the classes going and maintain the interest and character of the teaching it is necessary for the two instructors to canvass constantly the members of the classes and to strive continually to keep the attendance up to a good mark. There is an average attendance of about 50 percent of the enrollment.

Future of the Work

It might be wondered what are the prospects for the future of this work and the reply is that the work is more promising at the present time than any year since the start, except the first, and this is said notwithstanding the present depressed condition of the coal business. Mr. Hutson writes:

An even 200 men have been enrolled in the night classes and summer school of the present year, who had received no previous instruction. This should prove that it is still possible to interest new men in the classes, after the work has been in progress for seven years. In the seventh year of their existence, the night mining classes have the largest enrollment and the largest average weekly attendance in their history.

DISCUSSION

Vocational Training Among Coal Mine Employes

Chas. Enzian, *chief engineer, Consolidation Coal Company, Fairmont, W. Va.*

This is a subject on which I feel nothing other than a general and very comprehensive outline of Dr. Rutledge can be prepared as a set paper. To my mind, the greatest real value of such a paper to a meeting of this kind, I feel is from discussion from the floor, and would be more helpful than a set discussion paper. With your indulgence, I am going to reminesce somewhat on this subject of vocational training.

About October, 1906, Mr. Charles Fay, then general secretary of the Pennsylvania State Y. M. C. A., became very much interested in the subject. Through the collaboration of a number of men from West Virginia (particularly a very good friend and high-school mate of mine, the late Prof. E. N. Zern, of the University of West Virginia), recognizing the need of vocational training in the mining industry, undertook, as I said, the work, choosing the very happy channel, the Coal Mining Institute.

My early training was gained in the anthracite region. I had the benefit of associations among mining men who came to the anthracite region, and a considerable number of them to the bituminous region, from the United Kingdom, especially from Wales. They were a type eminently qualified through experience and training, and very often perhaps a very meager education, to undertake and direct the intricate work of anthracite and bituminous coal mining.

Dr. Rutledge, at times, when in a less serious mood than he has been this morning, refers to the Pennsylvania anthracite region as "the region of 17-story mines." There are not quite that many stories throughout the entire region, but it is not uncommon to have 12 or 13 seams.

Mining men who have had experience in the Georges Creek region of Maryland—Dr. Rutledge's state, and the mining is done under his inspection there—recognize the difficulties that are involved when seams of such thickness are mined in close proximity to other seams, such as, for example, the relation between the Georges Creek or Big Vein and the Tyson seams. That difficulty is considerably augmented in the anthracite region because some of the seams are thicker, the strata thinner and much harder and more brittle.

It is, therefore, apparent that a skill in mining is called for and is absolutely essential. Most of us men, I think, have had the very good fortune of having worked under men ripe in experience from Great Britain, especially the Welsh mine official.

The need for vocational training, however, became apparent in that region, just as it was apparent and was recognized by state legislatures that Dr. Rutledge spoke of, and instead of, at that time, having state aid the work was carried on through the cooperation of mining institutes, Y. M. C. A's, coal company help, and a very considerable progress has been made, and a very decided helpfulness established.

Hearing the statements of Dr. Rutledge as to the decrease in the enrollment of the technical students in the course of mining engineering is not at all comforting. There is no doubt that it has been recognized, and openly admitted, in these meetings during the last five or six years, that the mining engineer, the coal-mining engineer, is about to come into his own. He is being realized and recognized as a highly essential factor in the development and the economical operation of mines.

With the falling off of enrollment in mining engineer courses in our higher education technical institutions there is a hopefulness in these vocational schools. I will not burden you with many figures, but the speaker has knowledge of one form of industrial vocational educational

work that I do not think has many duplicates. I am going to give it to you gentlemen as something to think of.

The state departments, of course, are the natural channels through which this work should be conducted. Yet there are isolated, or rather detached, areas, mining areas where the population is sparse. It may not be economical to conduct a state-sponsored night school. An instance where a prominent coal-mining company, which the speaker has observed, organized a mining night school as a matter of necessity of developing its supervisory force, and the money expended, and the results attained, proved the policy very much worth while. About seven years ago this company organized its first night school on a three-year-course plan. A primary or first-year course, in which men, regardless of age and regardless of early educational training, could enroll. Then there is the intermediate course and the advanced course.

The men pay a nominal entrance or registration fee each year. This fee barely covers the expense of books and other supplies, and is considered mainly a registration of right to attend the school. It is well known that anything offered for nothing to a man, as a rule, is not considered of much value. It was felt that if the students were sufficiently interested to pay an entrance or registration fee they would retain a part ownership or partnership in that school, and they do. That is, after all, the best booster one can have.

Upon completion of this course and passing the state mine foreman's examination of competency, the student is given a certificate of completion of the preparatory mining course. Along with that certificate he is handed a check refunding all the fees he has paid. It was found that that was a great incentive for men to stick to it. The certificate is highly prized, and the men who secure them have been found to be very much worth while. Experience during the seven years encouraged the management in its efforts to the point that it feels if they secure only two men well qualified for the supervisory positions the time and money expended is considered well worth the spending.

I might go back just a little bit further in the history of these night schools. As Dr. Rutledge said, it was back in 1894 that they started. That date has been verified very closely from the speaker's personal investigation. It had its inception in a group of young fellows engaged in mining, whose hopefulness had practically been shut off. Unless one had enough education to pass a mine foreman's or boss's examination, there was no hope of attaining an official position. A group of public-spirted young fellows undertook to help other men in these studies. That started back in 1894. Such men in the anthracite region as Mr. W. D. Owens, Mr. Thomas Thomas and Mr. Beard, who is still active at the present time in educational work, as most of you know, were some of the real pathfinders in this work.

It is encouraging and hopeful to know that state institutions, especially such comprehensive summer courses as are offered by the University of Maryland, and that Dean Holbrook organized while at State College, Captain Steidel at Carnegie Institute, and Professor Lawall and Dr. Nold of West Virginia and Ohio University, respectively, have organized, are sponsoring courses for the mining men. Such efforts surely merit every man's support and encouragement.

Let me leave just one more point with you, gentlemen. Unless you men and your supervisory forces—your foremen and assistant foremen—take a real interest in selecting men, picking men from the rank and file of your mining organization and recommend them for, or get them interested in, this vocational work, it will not be as fruitful in results as you would hope it to be. We all hope it will be fruitful. It merits complete coordination of efforts, sympathetic interest and an appreciation of the real need.

Milton H. Fies, *vice president, DeBardeleben Coal Corporation:*

Students of our civilization tell us that the age in which we live is and will be known as the "Machine Age." "Machine" has not the romance and glamor of "Periclean," "Renaissance," and "Victorian," but it can mean very much more.

A great historian has said that, "It is one of the significant phases of history that the development of political democracy during three revolutionary centuries was occasioned by the rise and growth of science and invention." This is true though one is at a loss to explain why the world had to wait thousands of years for the steam engine and the formula of atomic weights. Why, Rousseau was working on his "Social Contract" at the very time that Watt was bringing the steam engine to an operating basis.

Yet there is no doubt that the influence of science on democracy has been reciprocal. This Machine Age is directly the result of scientific thought, and scientific thought is the child of democracy, because democracy demands that the man of the microscope and test tube come into the world to invent, relieve and serve.

On the other hand, science pointed the way to progressive democracy, in its warfare against starvation, poverty, disease and ignorance, and indicated how classes and nations long engaged in strife among themselves might unite to wring from nature the secret of security and the good life. "It was science, not paper declarations relating to the idea of progress, that a last made potent the practical methods by which democracy could raise the standard of living for the great masses of the people."

This Machine Age, therefore, can contribute more forcibly to civilization than any other age, because the aim of civilization is the happiness and contentment of man.

Coal is the basis of the Machine Age, say what you will. Coal, therefore, must, in the future as it has in the past, play its part in furthering and quickening happiness and contentment. Therefore it is most fitting that the American Mining Congress give time and consideration to the matter of personnel training, for personnel training aids in the development of civilization.

We hear a good deal nowadays about the new humanism. There is a direct correlation between humanism and science as applied to human needs, because humanism seeks to make science the servant of life.

Personnel training is a phase of humanism that possesses many ramifications, entailing good that can not be estimated.

An authority on the subject has defined personnel administration as the "work of directing human relations with the idea of productivity, good will and positive regard for the quality of the life of all the workers—regard for human well being." Successful personnel administration, which is the basis of personnel training, depends entirely on a knowledge of human characteristics. Fundamental and unchanging among these is the desire for justice on the part of the workers, and that business organization which tries to satisfy this hunger has solved one of the major problems of administration.

From my experience, I would say that all personnel work must start with, or be inspired by, the chief executive of any business organization. The soul of any organization must necessarily have inception in its head.

In spite of the fact that the coal industry has been described as lagging financially, it is all the more to its credit that personnel training has not been neglected. It is safe to predict that if, in an industry that has suffered many unfortunate phases during the last six or eight years, there has been much effort to further and develop personnel training. As time passes and revival comes, as it surely will, this industry will be a potent factor and a great influence, not only in a material way but in the fulfill-

Exhibits in one end of North Hall

ment of high ideals that make for human progress and happiness.

The first and sole approach in the matter of personnel training, if we are to persist, should be a social consciousness, if you will, an eagerness to drive home the truth that a corporation is not only recognized for the quantity of its material production but for the quality of the justice and human sympathy and kindliness it practices.

It is not my purpose to dwell upon this matter, because you have able speakers here to address you.

R. M. Lambie, *chief, Department of Mines of West Virginia:*

Due to the rush of business in our department, I did not have an opportunity to read the splendid paper prepared by Dr. Rutledge until this morning. He has given a very complete outline of mining educational work in Maryland.

The work that Maryland is doing is carried out on somewhat similar lines to that which has been conducted in West Virginia for the past 18 years. The State of West Virginia has eight instructors in the field teaching mining at the present time. In addition, one man is assigned to foremanship training, all of which is proving of great help to the men at the mines.

No mining course or extension work can be carried out successfully unless it has the support and backing of the State Mining Department, therefore the members of my department and myself, being very enthusiastic about mining education, give help and assistance whenever possible. In the beginning of the school year the mine inspectors accompany the instructors to the mines and have conferences with the officials, so that the proposition is presented to the men in the best manner possible. This has proved very effective and is appreciated by the men at the mines.

The change by the Department of Mines of having only two examinations for mine foremen and fire bosses each year has proved a great help to mining education, as these examinations are held at the completion of the summer courses and in the towns where the courses are given. We find in the state examinations that 83 percent of the men taking the mining extension courses pass, and only 57 percent of those not taking this training qualify. This, in my opinion, speaks for itself, and should prove effective as an argument as to why men should attend these courses.

The coal companies in our state are selecting men from the ranks who show promise of becoming officials and sending them to the summer school. This is a good investment, and I hope that the practice will grow.

Professor Lawall, head of the School of Mines, follows me on the program, and I am sure he will give a complete outline of the vocational training under his direction.

H. E. Nold, *professor of mine engineering, Ohio State University:*

We are indebted to Dr. Rutledge for calling to our attention the importance of vocational schools for coal-mining men, and for telling us how he has so successfully carried on such work in Maryland.

Miner's Night Schools in Ohio

The Department of Mine Engineering of Ohio State University, cooperating with the State Board for Vocational Education, is doing similar work in Ohio. The direction of the educational work in these schools is under the writer's direction.

Please notice I use the term "vocational education" and not "vocational training." The word "training" is not broad enough to describe the work we are attempting to do in Ohio. To educate is to develop and cultivate mentally and morally; to expand, strengthen and discipline the mind; to prepare and fit for any calling or business by systematic instructions.

We in Ohio try to emphasize the mental development. We try to induce clear and logical thinking; to get the men into the mental attitude of asking why and to give them the background of fundamental education, so that they can answer their own questions.

There are two schools of education. The one school studies certain facts about a mine or mining operation and then attempts to explain the reasons why. The other school studies some of the fundamental laws of nature (chemistry, physics and mechanics) and then investigates their application to mining problems. We in Ohio follow the latter procedure. We study, for example, in a rather elementary way, the fundamentals of chemistry and physics as they apply to gases and then apply the principles we have learned to a study and explanation of mine gases and ventilation. In other words, we study natural laws and theory, and then see how these can be used to explain mine phenomena. This we believe to be the most practical kind of education.

In this work we are receiving a gratifying cooperation from miners and an ever-increasing cooperation from mine owners, operating officials, and the state mine inspectors.

Attendance

Attendance is one of the major problems in miners night schools. Each year we find quite a number of men who are curious and enroll in the classes with the apparent idea that the school will afford good entertainment one night per week. Such men usually drop out when they find they are expected to do some studying. For example, in September, 1929, we started with an enrollment of about 420 students. A number of these came only a few times. By January, 1930, the enrollment was reduced by 35 percent, leaving an enrollment of men who were attending with fair regularity of 277.

A study of the enrollment as of January, 1930, shows the following:

	No.	
General superintendents, district superintendents and mine superintendents	23	
Operators	5	
Mining engineers and surveyors	18	
Mine foremen, assistant mine foremen, outside foremen and section foremen	62	
Fire bosses	5	
Safety officials, including deputy state mine inspectors	14	
Boss drivers	2	
Total in official capacity.	129	or 47%
Mechanical department—electricians, pumpers, motormen, engineers, etc	41	or 15%
Coal loaders	37	
Mine laborers	27	
Coal cutters	6	
Total miners	70	or 25%
Miscellaneous, weigh bosses, office men, etc	37	or 13%
Total	277	— 100%

Our attendance during the past winter months has averaged 62 percent, and will probably average less during the remainder of the term. In comparison with vocational schools in other industries of Ohio, where the attendance is near 100 percent because the schools are held during the day on company time and with a selected group of men, our percentage of attendance seems small and undoubtedly it should be higher, but we must remember that miners frequently work overtime, or are prevented from attending by inclement weather conditions.

Instructors

I want to stress another point, which is implied but not emphasized in Dr. Rutledge's paper. I refer to the qualifications of the instructor. To be successful the instructor of Miners' Vocational Schools must have sufficient practical knowledge of mining to demand the men's respect; therefore and at the same time he should have a rather thorough grasp of mining technology and the sciences upon which it is based. He must also have a liking for teaching combined with the ability to classify his material and present it to the class in such a simple and interesting manner that he can make them understand it, hold their attention, and develop in them a real thirst for knowledge. Such a man is difficult to find, but once found he soon becomes a real influence in the mining district in which he works and is worth more than the meager salary he generally receives.

We feel gratified at the cordial reception and support given this work by both miners and operators. We believe the work is meeting a real need. We feel optimistic about the future of such schools.

C. E. Lawall, *head, School of Mines, West Virginia University, Morgantown, W. Va.:*

West Virginia, through the Mining Extension Department of the School of Mines of the State University, offers to the mining men of the state opportunities for study to increase their knowledge of mining. This work is directed chiefly to aid men who are already employed in the mining industry and who need to supplement their experience with some elementary mining and management courses. The mining extension movement in West Virginia is based on the principle that "it is the duty of the state through one of its established agencies to extend an opportunity for educational betterment to those who, in their earlier years, have failed by reason of adverse environment to acquire a good schooling."

In any plan of vocational training the character of the training must depend and be directly applicable to the worker's job, because the value of any vocational training is determined by the effect it has on the productive capacity of the worker; that is, either on his ability to do things or to get things done. Realizing this, the Extension Department of West Virginia University employs men

for its instructors who have had considerable experience in the coal mines and who have had at least a good, common-school education. Our instructors are employed on a full-time basis and devote all their time to our extension work. They teach their classes, grade the home-work books of their students, and in addition are required to keep in close touch with the things that are being done in the mines of their district. We require them to visit the mines of their district frequently, and often ask them to submit a report of their inspection trips, so that they will make a careful study of the mines they visit.

We find that a very valuable part of the training men get in our extension classes, especially in our foremanship classes or conferences, is the ability they acquire to look at various jobs from different viewpoints. This is brought about from the discussion of various jobs in the classes. Today more than ever we benefit by the experiences of others, and this is especially true in mining work. This part of the instruction is a big factor in helping men to realize the importance of getting all the facts about a matter before jumping at conclusions. In the class discussions the experiences of the men are collected, collated and compared, and then these discussions are finally summarized into principles and rules, which are very valuable aids in deciding what action should be taken in various management problems that confront the mine official.

We have found that if our extension work at any mine is to be successful, it must be followed closely by the mine superintendent or mine manager and should receive his sympathetic interest and indorsement. One way that he can show this interest is to inquire frequently who are attending the classes and make advancements as far as possible from the members attending classes. The men will respond to such interest in their progress, and it will quickly become known that only those who study can expect to advance.

An intimate knowledge of the mining regions of our state with its 100,000 miners reveals the need for mining extension work, such as the Mining Extension Department is carrying on, and the unusual success that this department has had in bringing to the mining men a more thorough understanding of their problems has established this work throughout the state. The department has widened the period for miners, who left school at an early age, to obtain a formal education, and over 1,000 men each year are avail ing themselves of this opportunity.

That the men of the coal industry are eager to learn more about the whys of things and are interested in advancing themselves in their vocations is attested by the fact that during this past year 1,186 men were enrolled in the Mining Extension Department. Of these 1,186 men 7.25 percent were under the age of 20, 36.09 percent were between the ages of 20 to 30 years, 38.35 percent were between the ages of 30 to 40 years, and 18.31 percent were over the age of 40 years. These figures clearly indicate that this department is reaching those students for whom it was primarily intended, and sets forth that this department is an important factor in the adult education program of the state. The example of nearly 1,200 mining men studying diligently night after night in the Mining Extension Department throughout the school year to obtain an education, I know will impress you with the importance of this type of work.

During the past year 10 foreman development classes were taught in the state. This is a significant trend in mining education. It means that the coal industry is beginning to demand a more thorough understanding of management problems on the part of its minor executives. Our Extension Department now has the staff to do more of this work, and each year more requests are coming to us for this type of training.

A. C. Callen, *professor of mining engineering, University of Illinois:*

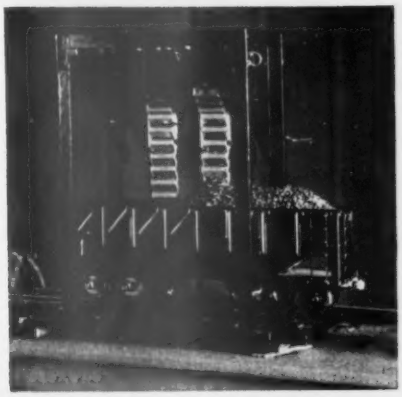
I would like to say just one or two words on the subject of vocational mining education with the paper by Dr. Rutledge. He said, in closing, that this type of work was giving him one of the greatest satisfactions of his life.

I can testify to having had that same experience. During the seven very pleasant years I spent at West Virginia University one of the greatest satisfactions I got was from the short courses given in summer and the vocational schools conducted at night throughout the state. I was delighted to hear Professor Lawall tell you this morning of the continuance of those schools and of the expansion that is taking place. Those of you who may not have had contact with vocational mining education work can hardly realize what it means to the men and to the communities.

Some of you may not be familiar with the fact that in 1917 the Smith-Hughes Act was passed by Congress making available to the states certain Federal aid moneys. Unfortunately, from the mining point of view, comparatively little of that money is available for vocational mining education. Yet, I have the idea that there are many mining states that are not making use of this money to the fullest extent. If any of you are interested in voca-

(*Continued on page* 58)

Two interesting operating models at the Cincinnati Exposition



Training of Men at the Face

By F. E. Bedale *

THE education of the man at the working face is a duty in which all of the officials of the company, either directly or indirectly, play an important part. In the endeavor to accomplish this desirable result the various problems must be analyzed, and dangerous or otherwise objectionable conditions and methods of mining eliminated.

If correct methods of education of the man at the face are employed and the work has the cooperation of all concerned, many benefits are attained. The company secures a larger tonnage per loader, safer conditions and fewer accidents; lower cost per ton, a reduction in labor turnover and more willing and satisfied employes. The employe secures more satisfactory working conditions, an opportunity to earn a better wage, better health for both himself and his family, and far better living conditions and opportunities for recreation.

Briefly put, the education of the man at the face generally covers health, safety, scientific methods of working, and the better preparation of the final product.

The methods of education are various, depending on the financial ability and willingness of the company. First of all, there must be the full and hearty support of the executive officers of the company. Without this nothing can be accomplished. Accepting that there is full executive cooperation, the general practice is to have a personnel department and a safety department. These departments are comprised of a chief, or chiefs, under whose direction the work is carried out; an ample office force and a field force consisting of doctors, nurses, recreation building managers, mine inspectors, safety inspectors, first aid and mine rescue instructors, and other minor officials, all carrying on a systematic educational and improvement work.

The education is advanced first by studying the entire situation and making a set of reasonable and applicable rules, usually known as safety standards and rules.

The plan of campaign having been outlined and approved by all concerned, contact is first made through the mine superintendent, the mine foreman, section foreman and other bosses, and finally to the man himself. This is accomplished by means of safety meetings at the mines, safety committees, safety courts, schools of instruction in the standards and rules, schools of instruction in mine rescue and first aid, safety contests, personnel contact men, visiting nurses, motion pictures, lectures, bulletins, posters, magazines and other pertinent methods, one of the best of which is the model working place. This model working place is a place maintained near the entrance in each mine for the instruction of new employes. In this place is shown the method of blocking cars, the standard method of timbering to be followed, the proper placing of holes for shooting, the separation and disposal of rock, boney and other impurities, the proper tools that the miner must have, method of storage of explosives, and place where cable, battery and other equipment must be kept. In this room the new employe is instructed in the various rules and regulations in effect in the mine which directly serve his welfare.

Undoubtedly the most important single feature is the "safety standards." These are prepared with a great deal of care and an attempt is made to cover all parts of the operations. A school of instruction in the standards is the first effort. Every operating official, such as superintendents, foremen, and others who come in direct contact with the man at the face, is required to attend the school, and upon completion of the course to pass a satisfactory examination proving that he is familiar with the standards. All these officials are supplied with and required to carry a full set of the standards at all times when on duty.

The next step is the organization of safety committees and the holding of safety meetings. The committees being organized, meetings are held when and where convenient—inside the mine on the various sections. These meetings are attended by officials and by all the men on the section; the standards are explained and safety features in general discussed. The men are all free to speak their minds and the meetings are held frequently to keep them interested.

Regular safety committee meetings are held outside the mine at stated intervals. At these meetings features of safety and other matters are discussed and arrangements made to correct any objectionable feature or practice.

The safety court is probably one of the most popular and best methods of advancing and teaching safety. It is peculiarly an organization of, by, and for the man at the face, and no official of the company is allowed to hold office or interfere in the proceedings. The court is comprised of a judge, prosecuting attorney, defense attorney, sheriff, and clerk, all elected by the men. The sheriff appoints safety police. Obedience to the court is, of course, voluntary, but in no case has it been refused and the men enter into it with considerable spirit. Officers of the company are subject to the court as well as the men. Any one may report violators of the standards or rules; a warrant is issued and served, the person haled into court and, if convicted, fined. The fines run from 25 cents to a dollar, and when sufficient have accumulated the proceeds are used for charitable purposes. Court trials are well attended and bring out vividly the violations of various kinds; the trial may be simply before the judge or by jury, as the defendant prefers, and it is apparent that the action, with the evidence given as in a regular court, makes quite an impression on the audience.

Classes in first aid are held regularly by company instructors and at certain times by representatives of the United States Bureau of Mines. All employes are required to attend these classes and the constant effort is to have 100 percent of the men trained in this work. To assist in creating interest in this work, first-aid teams are organized at the mines and contests are held, suitable prizes and rewards being given to teams making the best records.

Instruction in mine-rescue work is also given, the endeavor being to have at least one fully competent mine-rescue team at each mine.

Ample supplies are kept constantly on hand for both first-aid and mine-rescue work. First-aid stations are maintained at fixed intervals within all the mines and are equipped with a full supply of emergency materials. Receiving stations are maintained on the surface at each mine, also fully equipped for first-aid service. Fully equipped mine-rescue stations are maintained at specified points. At certain of the mines the men are instructed in the use of and equipped with self-rescuers, and when this piece of equipment is more fully developed it is expected to do this at all mines.

Classes of instruction are also held for all haulage men and machine operators; namely, motormen, brakemen and their helpers, machine operators and their helpers, and any other men who have to do with similar equipment. The men are instructed in the proper use and care of the various types of equipment, which results in more efficient work, longer life for the equipment, and cheaper production with less delay from injuries to employes or disabled machines.

The mine inspector makes regular visits to each mine, investigating all features of the work. He makes written reports to his chief, which reports are in turn sent to the mine superintendent. Twice each year the mines are rated, based on these reports. It is the endeavor of the superintendent to eliminate all conditions which will give him a bad rating. In addition to reporting conditions, the mine inspector keeps in constant touch with the man at the face; he visits his working place and gives him instructions in correct methods of working and safe practices. He is not just an inspector who comes around every so often and bawls some one out and has to be watched for and dodged—he is a friend and a buddy of the men, he is popular and respected, he does not hesitate to reprimand or to see that more severe punishment is meted out if justified—but he is also ready to praise and commend the good workman. The mine inspector also usually conducts the schools of instruction in the standards and frequently assists in first-aid instruction, the safety committee work, or such other features as may develop. All in all, the mine inspector is the key and most important man in the whole system.

The coal inspector has an entirely different duty and usually is under the

* Engineer of Safety, the Consolidation Coal Co., Inc.

direction of a different department, but his work ties into the instruction and bettering of the men at the face. It is the coal inspector's effort to see that the coal is properly prepared at the working place, as far as is possible, and at the tipple. If the coal inspector teaches the man at the face to send out better prepared coal it is obvious that both the man and the company benefit. At two of our larger mines two full-time instructors are employed at each mine to give instructions to new employes in the proper method of mining and preparing the coal. These men also follow up to determine if their instructions have been fully understood and are being complied with.

The doctors and nurses look after the health and sanitary conditions of the community in general and the man in particular. Their duties as to health and sanitation are self-evident, but they also assist in the general welfare work, making their locality more interesting and worth while.

Under the heading of industrial relations comes a department with a multiplicity of interests, all tending to better the condition of the man and his family as to health, morals, and recreation. An attempt to show the employe that the company is not a soulless corporation for whom you do as little as possible to get as much as possible, but a concern where an honest day's work is rewarded, not only with a day's wage but with a safe place to work, interest and care for the health and welfare of his family and living conditions and recreation beyond that provided at average places and better than he has ever before experienced. This department maintains direct relations with the man at the face through what is known as the personnel man. He is on the ground, sees the family, visits the man both at home and in his working place, listens to his complaints, his illnesses, his family and financial difficulties. The personnel man's job is difficult; he must have skill, human sympathy and diplomacy, and must constantly carry in mind the interests of both the man and the company. He is the "fixer" and one of the most important contact men in the campaign of education.

Leaving now the force which, for want of a better term, we might call the executive operating organization, we come to those men who are directly responsible for the production of coal and all that that implies, the superintendent and the mine foreman.

The superintendent is the most important man on the job; to educate the man at the face he must, himself, be educated, and he must be fully and wholeheartedly back of the plans for betterment and safety. The superintendent is ex officio the head of the safety committee; he presides at the outside committee meetings, arranges for schools of instruction in the standards and in first aid, and sees that the men attend. He keeps up interest in the safety court, sees that meetings are held inside the mines and that special committees investigate accidents or improper conditions and generally looks after his community.

The mine foreman is, not only by order of the company but also by state law, in full charge of everything underground; he is responsible for every condition that exists within his mine. He may have a number of assistants, known as section foremen, but in the final analysis it is the mine foreman who must take the blame or receive the praise for inside conditions. It is therefore to his best interest, and he does his best to fully cooperate in the campaign for education of the man at the face. He conducts the meetings which are held underground, sees that the section foremen and his other helpers are fully informed as to the standards, and that each man underground is familiar with that part of the standards governing his particular class of work.

The section foreman, in his work as assistant to the mine foreman, has a limited area and limited number of men whose work it is his job to oversee. In this capacity his opportunities for educating the man at the face are unlimited. He is the man's direct superior, tells him where to work, what to do and how to do it. He visits each man several times each day and praises or reprimands him as the occasion warrants. The importance of selecting capable section foremen and then thoroughly educating them in their work can not be overestimated and is a feature which should be constantly kept in mind.

A discussion of the education of the man at the face could be continued for indefinite length, but you gentlemen who are familiar with mining and mining conditions will readily realize the benefits to be derived and can fill in the details. There is only one feature which must be constantly borne in mind and which can not be too heavily stressed; that is, that to make such a campaign a success you must have the full and complete cooperation of every official of the company from top to bottom. The executive officials, while they can not give time to the details of the plan, should keep in close touch with the situation. From time to time they should visit the mines and the various classes, attend safety court meetings now and then, and by all means attend safety contests where a little judicious praise helps the program wonderfully. Without executive recognition and aid the whole structure topples to ruin; with full cooperation there is no limit to the high point of success which may be reached.

DISCUSSION

Training Men at the Face

S. W. Blakslee, *general manager, Pennsylvania Coal & Coke Corporation:*

Mr. Bedale only read from notes that did not cover his paper fully. We all have been furnished copies of the paper and will enjoy reading it over many times.

I do not feel that I can add very much to what Mr. Bedale has had to say. He has pointed out, however, that a well trained miner is of great benefit to the company, himself, and his family. In detail he has carefully shown how the Consolidation Coal Company carries out its instruction work, and it is indeed of great interest to know to what extent a company will go in making its mines better places to work in and its camps better communities to live in.

In reading the paper, we learn that in the Consolidation Coal Company, to quote Mr. Bedale, "the mine inspector, (that is the company inspector) is the key man and the most important man in the whole system of training men at the face." It is from the mine inspector that the supervising force which is in daily touch with the miners get their cues.

There is one thought, however, that I want to inject at this time. It has already been dwelt on by Mr. Bedale, but I would like to emphasize it. It is the importance of having the instructors and supervising force well grounded in practical and theoretical underground methods of producing coal. The average miner is not very amenable to white collared advice or text book mining. He has his own ideas as to how the best results may be obtained from the use of shovel, pick, drill, and powder. He also is not easily sold on safety standards that deviate from the early and shop worn practices. Therefore it is essential that the training must be provenly sound and administered diplomatically and firmly.

Our company first realized the importance of well trained miners to the greatest extent with the advent of mechanical loading. We soon learned that we obtained a larger lump of coal with less effort, in a safer manner, and at a lower cost only when the thoughts of the engineers, the supervising force, the safety organization, and the miners had been properly mixed. We hold invaluable the thoughts and advice of intelligent miners and attempt always to get their thoughts and advice into the melting pot in no mean proportion.

J. W. Bischoff, *general superintendent, West Virginia Coal & Coke Company:*

In discussing a paper of this kind and after having read Mr. Bedale's paper, I haven't a great deal to add. In such a case you ortentimes have to fall back on your personal experience. In other words, you have to inject personalities into it.

For years all my experience has been in the northern part of West Virginia with the same company with which I am now associated. My activities have been transferred to Logan County. We have had a remarkably good record in performance as far as safety is concerned, in the northern part of West Virginia.

About three years ago I took up my duties in Logan County. One of the first things that impressed me was the all together too apparent lack of attention to details in the training of men at the face. The accident record was appalling. I had, fortunately, the whole hearted backing of my superiors and we organized safety clubs and met twice a month.

We gave particular attention to the men, and the results were surprising considering the class of labor we have. We have at least 50 percent negroes, and possibly 75 percent of the remainder were native southern West Virginians. In other words, while I wouldn't want this to get back to Logan County, we had a very inferior class of labor.

The average number of fatal accidents per year for Logan County for the com-

pany was 13, with an average daily production of about 10,000 tons. We prosecuted this matter of training the men by propaganda, association of ideas, and so forth, and during the last calender year we had five fatal accidents. Two of them were in Logan County. Unfortunately, and at the same time fortunately because no more men were in the mine, three of them happened in one of the operations in the northern part of the state early in the morning when an accumulated body of gas killed three men, all that were there. That was the first experience of that kind we ever had. But excluding the three due to an explosion, we had only two fatal accidents during the last calender year.

As I said, it is a matter of training, and too much importance cannot be attached to the duties of the mine foreman and even the assistant mine foreman. You might take the best educated, the best trained mining engineer in the world; he knows every kink there is to be known about mining, and you might put him in charge of an operation and he will be an absolute failure.

Reverting to some remarks I heard this morning, you have got to get to the feature of humanism. You take a mine foreman and an assistant foreman who has some knowledge of human nature and he can accomplish more results in every respect, as far as safety and efficiency are concerned, than the best trained engineer available. It is a great field of work for him, and too little attention, I must say, has been paid to the human element, from the trapper boy to and including the superintendent in the field of coal mining.

J. A. Long, *general manager, Woodward Iron Company, Woodward, Ala.:*

Mr. Bedale has presented a very valuable paper and any attempt on my part to find fault would be futile.

We can see the need of doctors, nurses, mine safety inspectors, and men trained in first aid work. We can not, however, see the wisdom of personnel contact men and coal inspectors. We believe this to be the duty of the section foreman, who must be manager of his particular section, and feel that the effect of these additional men would be as detrimental to the foreman in charge as would a direct order from the general manager to the miner. What I mean is, these extra men, the coal inspector and personnel contact man, would, in a way, be looked upon as the means of by-passing the man directly in charge of the men at the face, and have a tendency to limit his personal influence with the men.

The instruction room used by the Consolidation Coal Company could not be used by our company, as we could not possibly cover all of the subjects of angles of the work. The instructing of our men is strictly up to the foreman, who is held responsible for his men. We actually suspend foremen for the same period of time that an injured man loses due to injury that the foreman was responsible for. Each employe is given an instruction book when employed, which is revised very frequently in order to cover, as far as possible, all angles of his work. We discontinued the use of safety committees beginning in January 1929, also all "catchy" pamphlets, slogans, etc., using only warning signs, such as "Workmen Above," "No Clearance," etc.

Safety with us is not a side issue, and we have found that by insisting that safety is nothing more than doing work in an efficient manner we obtained far better results, and safety with us is synonymous with good operations.

In support of the foregoing statement, I will submit the following data covering our fatal and serious accident record at our coal mines for the year 1929, compared with the preceding two years:

Year	Fatal Accidents	Permanent Total Disability	Permanent Partial Disability	Net tons Coal Produced
1927.....	7	1	15	1,067,381
1928.....	8	0	8	1,082,933
1929.....	2	0	7	1,305,173

Monthly safety meetings are held at all mines, with an attendence of approximately 50 percent of all men in the division. These meetings are held beginning at 7 p. m. Soft drinks, sandwiches, and cigars are served and this seems to produce good fellowship spirit. The division superintendent acts as chairman, and all accidents occurring the previous month are discussed. All foremen and all witnesses to accidents must attend, and if possible the injured parties are required to be present. We experience no trouble whatever getting facts from all parties and decisions on the acidents are rendered at once by the superintendent. Our company has a standing offer of a Barbecue to the mine, either coal or ore, that goes one calender month without a man-day lost. We have had one barbecue this year in the ore division. One day off is counted as a lost time accident, and we do not allow a man to return to light work; a man injured is off until he is able to resume his regular duties, and we have no men on the job bandaged or limping around. (Parenthetically, it was brought to my attention recently that we had more men in our Mining Department off on account of injuries sustained off the job, than on the job).

About 60 percent of all employes have been trained in first aid—this includes surface works such as blast furnaces, coke plant, central shops, railroad department, etc., and on July fourth each year a contest is held between departments or divisions, a cash prize being given each man of the winning team—both colored and white. Cash prizes in our estimation are more satisfactory than trophies. We have several first aid teams, white and colored, in each mine and we keep them recruited up to full strength at all times. It is not unusual to bring a man out after giving him first aid inside the mine and have the doctors pronounce it O. K. and take the injured man to the hospital without altering the first aid dressing.

A Health and Sanitation Department is absolutely essential to the welfare of both man and company, and what we believe to be a good health and sanitation department is maintained.

The department of Industrial Relations has never been tried by our company. We use Mutuality Committees in all departments. This committee is composed of three men from the ranks, no foreman being eligible to serve on the committee, and are appointed by the division superintendent to serve a period of three months. To this committee a new man is appointed each month, and one of the committeemen who has served his three months is dropped. Once a month the Mutuality Committee of each mine or manufacturing plant visits all the workmen at their working places, and any trouble, complaint or unsatisfactory conditions are given to the committee who in turn give it to the man's immediate foreman, and if there is not a satisfactory settlement made between the man and the foreman the matter is turned over to the superintendent for action. Through this committee, if the workmen do not feel that they have received justice, they have access on up to the president. In this connection, it would be well to state that each committee makes a written report of all complaints given them by the men and a copy of this report is furnished the foreman immediately in charge of the man making the complaint, the superintendent, the general superintendent and the general manager. Thus far, after a period of something like four years, it has never been necessary for a workman to carry his complaint beyond the superintendent, excepting in a few cases where it was necessary to obtain executive decisions touching policies of the company. In addition to the regular monthly visits of these committeemen, they are available at any time to receive complaints. The committeemen's names are posted on the bulletin boards and they are furnished a special badge to wear designating them "Mutuality Committeeman." It is thoroughly understood by this committee and the workmen that no complaints will be considered which have not previously been taken up by the man with his immediate foreman, and on which he has not obtained action which he feels his case justifies. This committee receives complaints touching living as well as working conditions, and there is no foreman in the organization foolish enough to "ride" a man who complains to the Mutuality Committee. We experience no trouble getting men to serve on this committee—the men deeming it an honor to serve, and they look on this committee as "their committee." The men serving on the Mutuality Committee receive their regular rate of pay for the period of time it takes them each month making their inspection. Twice a year, all of the Mutuality Committees from the mines are called in to the office of the general superintendent of mines and an open meeting is held for the discussion of conditions, the activities of the committee, etc., and to encourage the men to keep their committee functioning on the high plane to which it has been brought.

The company maintains a Department of Humanics and Welfare whose director is in charge of the schools maintained for the children of employes. Physical education and domestic science receives very careful attention and these two branches of the service are maintained the entire year. The director of the Humanics Department is also general chairman of the Gratuity Committee, which, in cases of sickness or other misfortune among employes and their families, appropriates funds for their relief.

This is more of a story of how we do our training than a discussion of Mr. Bedale's paper, as we believe that one standard of training men can not be used any more than one system of mining coal mechanically in seams of the same thickness.

Developing Bosses and Coaching Men

By Gomer Reese *

COAL mining is one of the most important industries in the State of Wyoming, and it has advanced to the point where science and education are essential to the best interests of the miners and operators.

Our first thought must be: Are our bosses fit, and are the other men capable of performing their tasks properly and safely? So it appears to me that developing bosses and coaching men is a question of vital importance to the operator and to the miner as well.

In the past, I have found that bosses have had to be developed by the executives in charge of operations, using men who are found on the job. The men in charge put forth every effort to coach such men carefully. While this method has given splendid results, it has proved too slow, because after a prospective boss is found he often proceeds slowly, and many times just for the lack of one thing—education.

Men who will make good bosses must possess certain qualities, namely, leadership, courage, initiative, reliability, and loyalty. To find men with these qualities is in itself a problem, as it requires constant scrutiny of all the employes, so as to be on the "lookout" for those who stand out among their fellow workmen by showing these traits.

I may state, without exception, that all the bosses in this district have been developed from the bottom on up. They are men who, in their youth, started at the bottom of the coal industry and through their leadership, courage, initiative, reliability and loyalty have gradually worked to the top. Occasionally we find a man who possesses the necessary qualities, but he does not seem to realize it. This type of man, with careful coaching, often develops into a valuable boss, and may be found in any of the various branches of mining, from the trapper boy to the office and engineering departments.

Not only prospective bosses, but each and every man in and around the mine must have teaching in one line or another. So it appears to me that we can look only to our high schools for relief in this situation. Now is the time to lay the proper foundation for the training of those who are to soon take their places in the ranks of the mining industry. Formerly it has been almost impossible to induce high-school graduates to enter mines to work, and, no doubt, because they felt that they were not fitted for such an occupation. Those we did get came to us green. Each and every one had to be watched carefully, and were taught how to do this and that.

In the coal-mining regions there is no reason why schools should not offer work that will assist young people to carry on coal mining. I do not feel that they should not get cultural or college preparatory work. It is splendid, but young folks should have some practical work along with the other.

The mines are becoming mechanized rapidly, and here again is a cry which makes vocational training necessary. The man who is now working in the mines needs help. The future miner, the youth of today, will be able to give better service when he begins, if he receives this training in school. Being better educated, he will grasp the ideas quicker, and will be resourceful enough to go ahead on his own judgment. No man can expect to reach a higher position without effort and study.

In the Kemmerer district, during the past year, there was introduced into the high school a splendid course of mining. This course is carried on under the auspices of the Department of Education of the State of Wyoming, coming in the division of vocational education. It is under the Smith-Hughes vocational education plan. I am sure we will receive a surprise at the type of youth which this course will develop. His ability will be far in advance of the ordinary workman, because he will be well trained in the various branches of mining. This course is divided into two divisions: First, all-day school preparing boys for the trade; second, evening classes for those already on the job.

The all-day division offers a course of study which enables a boy not only to become a good miner but will permit him to enter college if he desires to do so. Boys taking the mining course must devote 60 percent of their school time during the last two years to the course. Half of the day is spent in actual shop and laboratory work, the balance with related subjects. The subjects are correlated by and are under the supervision of a Smith-Hughes supervisor, while he does not actually teach the classes. Thus a boy comes under the Smith-Hughes plan during his junior and senior years in high school. The course at Kemmerer is under the able teaching of a competent mining engineer, who not only sees that his boys receive the proper teachings in class and shop work but who takes them into and around the mines, so that they can get first-hand knowledge of the subjects of which they are studying.

The night classes are divided into two classes: First, mine rescue and first aid; second, all other subjects for betterment of workers. These classes are taught by competent teachers and safety engineers. Already we are noticing improvement in our workers.

Through past experience of high cost relative to accidents, both fatal and nonfatal, it has been proved to me that there can not be too much time put to the coaching of men in first-aid and mine-rescue work. This branch of training must apply to everyone in and out of the mine and eventually should be 100 percent. Mine-rescue and first-aid work is carried on in all of our camps for men, women, and children with pleasing results. All the companies in this district who have entered into a snappy program of first-aid and mine-rescue work have noticed, without a doubt, a vast reduction in the accidents in and around the mines.

The high-school mining classes, night classes, mine-rescue and first-aid work are all being carried on under the auspices of the Department of Education, division of vocational education, and are financed by Federal, State, school district and coal company aid. This method seems to take better with the unionized miner than when carried on by the companies alone.

The foregoing movement of securing vocational training for this district was instigated by a series of conferences† held by practical operating officials of the different companies, the state director of vocational education, the superintendent and principal of the high school, and the heads of the State Mining Department.

In closing, I will say that, in developing bosses and coaching men, it is not only a matter of training the men who are on the job at present but it is vitally important that we put forth every effort to give the future miner every opportunity to get every bit of education available to fit him for the work he is to carry on.

* General Superintendent, Kemmerer Coal Company.

† The proceedings of the above mentioned conference may be had by writing F. M. Treat, state supervisor of trade and industrial education, Cheyenne, Wyo.; asking for a copy of "Report of Conference of Foremen of Kemmerer Coal Company and Diamond Coal and Coke Company.

The Joseph A. Holmes Safety Award

Presentation of the Joseph A. Holmes Safety Award Certificate to the Sheridan-Wyoming Coal Company

J. J. Forbes, *U. S. Bureau of Mines:*

Mr. Chairman, Members of the American Mining Congress: It certainly is a real privilege to have a little part in the presentation of this award to the Sheridan-Wyoming Coal Company.

This award is made possible by the Joseph A. Holmes Association. I might state for the information of some of you gentlemen that are not familiar with the workings of the Joseph A. Holmes Safety Association, that it is a memorial association, set up to the memory of Dr. Joseph Austin Holmes, engineer, humanitarian, and first director of the Bureau of Mines. Dr. Holmes gave his life to the cause of safety in mines. He is not with us here, but I am sure that he is here in spirit.

I would like for Mr. Bottomley, representative of the Sheridan-Wyoming Coal Company, to step forward and receive this certificate.

Mr. Bottomley, I extend to you the congratulations of the Joseph A. Holmes Safety Association for this outstanding achievement in safety record. I want to read for the information of you gentlemen what this award represents: "For having operated its three mines from 1925 to 1929, inclusive, with an average of 446 men, producing 4,116,998 tons of coal, with 27 lost-time, compensable accidents, and without a fatality or a permanent, total disability, and with one partial disability. Given in the city of Washington, District of Columbia, the fifth day of March, 1930."

May I also extend to you, as a representative of this company, the congratulations of the director of the Bureau of Mines, who is also president of the Joseph A. Holmes Safety Association. I hope you will tell these gentlemen just how this splendid record has been made possible.

Edward Bottomley, *General Superintendent, Sheridan-Wyoming Coal Company:*

To be thus honored by the Bureau of Mines I will always look upon as one of the happiest and proudest moments of my life. Personally, I don't claim any particular credit for having produced over 4,000,000 tons of coal without a fatality and very few serious non-fatal accidents. I haven't anything to brag about myself; the boys back home at the mines deserve just as much credit as I, perhaps more.

As I have said, I haven't done anything to brag about; we are only honestly endeavoring to do our duty to our company, to our fellow men, and to society in the best way we know.

A good many have asked me since I came to Cincinnati how we handle our safety work, what system we have, who is the safety engineer, etc. That would be too long a story to tell here. We do not employ a safety engineer for that particular work. It takes some time to build up an organization such as we have; it can't be done in a week, a month, or a year, and, even if I had some ability as a speaker, I couldn't begin to tell this audience how to do it in five minutes, a half hour, or an hour, so I will not take up any more time of this convention.

I will say in conclusion that I want to thank the Bureau of Mines, and we greatly appreciate the honor they have conferred upon our company.

MR. FORBES: Will you tell the gentlemen here approximately what percentage of that record is due to mechanized methods?

MR. BOTTOMLEY: That, too, would be a rather long story. Mechanized mining has something to do with that record, no doubt. Had I known that you were going to ask me that question, I might have given it a little thought. It has had some effect for this reason: On hand work the miner has various duties to perform in the course of his day's work—loading, drilling, shooting, setting props, and the like. In mechanized mining it is an entirely different story—men are employed that are the best fitted for each particular class of work and soon become specialists in their line; for instance, in our mines cutting, drilling, charging and shooting are done by men that are employed for that purpose only. Trimming down loose top coal, loose coal at the face, setting props and removing all dangerous conditions, as far as may be anticipated, before the loading machines enter a room to load coal, is performed by other men. Thus accidents, which are often the result of the reckless haste of the average miner in his hurry to get his car loaded, especially the first one in the morning, is entirely eliminated in mechanical loading. Mr. McAuliffe and other mechanical operators, I believe, have discovered this also. These, I believe, are the principal reasons that the elimination of contract loading is responsible to some extent for our fairly good record.

Our three mines are all 100 percent mechanized now, but only about half of our coal has been loaded mechanically since we had a fatal accident in 1924, so our record is not all due to mechanized mining or luck either. Gentlemen, I thank you.

CHAIRMAN FIES: Mr. Bottomley's record is certainly an outstanding achievement, and I wish that he might prepare for you or inform all of us as to how he obtained this splendid record. A production of over 4,000,000 tons of coal without a fatality is indeed something of which any man might well be proud.

Exhibit of the U. S. Bureau of Mines at Cincinnati

Entry Development with Conveyors

By John H. Richards *

IT is not the purpose of this paper to make any startling announcement or to proclaim any particular method or machine as being the savior of the coal industry. The subject, however, is one in which you are all interested. The writer does not claim to be any authority on mechanical mining so he will only attempt to give the benefit of the experience of one of the pioneers of mechanical mining in eastern Ohio, the Wheeling & Lake Erie Coal Mining Company.

The No. 9 mine of this company is at Fairpoint, Ohio, about nine miles west of the Ohio River. The No. 8 or Pittsburgh bed is being mined through a drift opening. It will average about 5 ft. in thickness and is directly overlaid with 6 to 15 in. of draw slate, which must be taken down and removed immediately after the coal has been taken out. Directly over the draw slate is 4 to 12 in. of roof coal which forms the top. This top is tender and when broken, releases about 6 ft. of soft shale. Directly above the shale is the Pittsburgh limestone. Due to the draw slate which at times comes down when the coal is shot, and the middle bands which are regular in this bed, mechanical loading necessitates mechanical cleaning. For this reason, a Simon Carves cleaning plant has been installed.

* Chief Mining Engineer, Wheeling & Lake Erie Coal Mining Company.

One shaker conveyor, equipped with a duckbill loader, was first installed. This conveyor is driven with a 20-hp. power unit, and as it is possible to drive an entry 400 ft. with one set-up, the first problem encountered was that of ventilation. This was accomplished by the use of a small ¼-hp. auxiliary fan and a 12-in. canvas ventilating tube. The results of the first method used are shown by *time study No. 1.* You will note that for the period covered, an average saving of 30 percent was made over the hand-loading cost. In addition to this, the average per shift was 13½ ft. This is an increase of about 9 ft. per shift over hand loading, making it possible to develop territory three times as fast as could be done by hand.

It was necessary, by using one machine, to develop only one entry at a time and when it had been driven its distance, the conveyor had to be set up in the parallel entry and the process repeated. To eliminate this delay, the method as shown in the accompanying drawing was devised. It was then possible to drive both entries at the same time. This method also simplifies the haulage problem as the empties are spotted in one entry and pulled through the breakthrough past the discharge end of the conveyor by means of a portable hoist. Gratifying results are being obtained by using two machines, as will be shown by *time study No. 2.* You will note that an average advance of 20 ft. per shift was made.

Five men are necessary to operate this double set-up. Two men cut the coal, drill and shoot the coal and drill and shoot the draw slate. Two men work at the face loading coal and stone. One man operates the loading end where the coal and stone is discharged into the cars from the conveyors. The man at the discharge end controls the operating of the conveyors and the hoist which feeds the empty cars to the discharge end of the conveyors. The men at the face communicate with the men at the loading end by means of two lights at the discharge end. These lights are operated by push buttons and in this manner the men at the face can signal to the operator when it becomes necessary to start or stop the conveyors. While coal is being loaded in one entry, the cutters finish cleaning the draw slate, which is loaded into the cars and dumped outside. When the cutters have finished shooting and loading the stone that is left by the loaders, they cut, drill and shoot the coal, preparing the place for the loaders.

When the entries have advanced their distance and it becomes necessary to move up to a new set-up, the cutters start tearing down one conveyor while the loaders are loading in the opposite entry. After the pan line on one side is torn down and the drive moved up,

THE WHEELING & LAKE ERIE COAL MINING COMPANY
REPORT OF TIME STUDY ON DUCKBILL LOADERS

DAY SHIFT

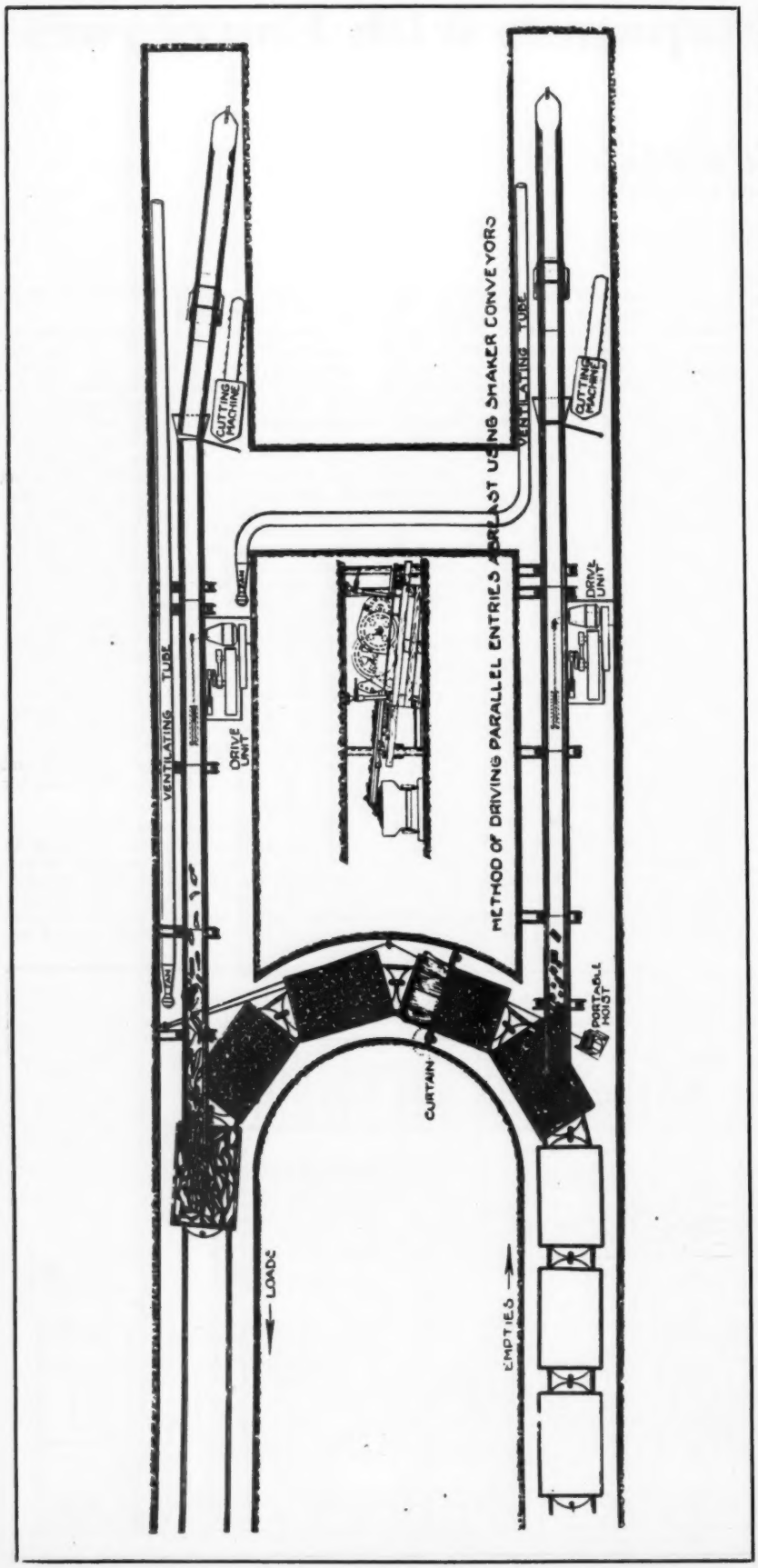
Date	No. Men	Cutting	Drilling Shooting	Loading Coal	Cleaning Slate	Posting	Advancing Conveyor	Time by Miles Cars Were Kept	No. of Feet Advanced	Tonnage	DELAYS: Breakdown of Conveyor	Shifting Cars	Power	Breakdown of Machine	Total Delays	NIGHT SHIFT: No. Men	No. Feet Advanced	Tonnage	Total Feet Advanced	Total Tonnage	Percentage of reduction in cost over hand loading	Remarks
DUCK BILL REPORT 5 West - 4 North No 9 Mine (Dillon)																						
1-28-29	3	2 10	1-55	1 35	0 55		0-20		7-15	11	20.05	0-45				0-45	3	5		9 20	5	9.20	36 %
1-29-29	3	2 30	2 05	1-30	1-30		0-25		8-00	11	20.90						3	18		29 10	29	30.30	35 %
1-30-29	3	1-40	2-05	1-10	2-05		0-40		7-40	12	18.10		0-10		Horn 0-10	0-20	3	14		26 25	26	42.35	26 %
2-1-29	3	2-00	2 45	1-20	1-05		0-20		6 30	13	17.45	0 35			0-05 0-10	0 50	3	17		24 20	30	43.45	21 %
2-2-29	3	1-50	2-50	1-30	0-45		0-10		7-05	12	23.35	0 45	0-10			0-55	3	14		27.20	26	50.45	35%
Average		2-05	2-08	1-29	1-16		0-23		7-18	11.8	20.13					0-42		15		26.27	27	43.30	30 %

Time Study No 1

DUCKBILL REPORT — 4 3 & 4 NORTH — NO 9 MINE

DAY SHIFT: CUTTERS — Date	No Men	Morning Machine	Morning Cutting	Cleaning Slate	Drilling Shooting Coal	Drilling Shooting Slate	Advancing Conveyor	Time by Miles Cars Were Kept	DELAYS: Machine Breakdowns	Power	Total Delays Cutters	DAY SHIFT: LOADERS — No Men	Loading Coal	Loading Slate	Drilling Shooting Coal	Drilling Shooting Slate	Cleaning Slate	Advancing Conveyor	Posting	Time by Miles Cars Were Kept	No. of Feet Advanced	Tonnage	DELAYS: Breakdown of Conveyor	Shifting Cars	Power	Total Delays Loaders	NIGHT SHIFT: No. Men	No. Feet Advanced	Tonnage	TOTALS: Total Feet Advanced	Total Tonnage
4-29-30	2	1-12	3-01		3-01	0 10	0 20	7-16	0-24	0-22	Horn 0-26 0-46	3	2-26	1 03	1-17	0-49		1 00		6-33	22		1-07		0-22	Horn 0-28 1-29	5	22		44	
1-21-30	2	1-12	3-01		3-09		0-20	6-00	0-50		Horn 0-35 1-25	3	2 10	1 10	0-42	1-30		0 19		6-01	16		2-06			Horn 0-03 2-06	5	27		43	
1-22-30	2	1-15	2-50	0-50	3-41			7-40	0-20		Horn 0-34 0-54	3	2 15	1-18	1 01	1-39		1 47		8-00	24					Horn 0-30 0-30	8	18		42	
1-23-30	2	1 23	2-17	0-40	2-30			6-27	1-33		Horn 0-33 1-33	3	1-27	1-16	1 15	0-36		0-56		5-48	11		2 18			Horn 0-30 2 18	5	20		31	
1-24-30	2	1-07	1-40	0-20	2 00			5-06	0-30		Horn 0-34 0-34	3	2-30	1-16	0-53	1 26		0-33		6-38	22		1-22			Horn 0-30 1-52	5	19		39	
1-25-30	2	1-00	2 36		2 52	0 29	0-26	8-00			Horn 0-30 0-30	3	4-14	1 21	0-14	1-29		0-26		7-46	23		0 25			Horn 0-30 0-55	5	23		46	
Average	2	1-13	2-40	0-36	2 52	0 08	0-11	6 53	0-36	0-04	0-36	3	2-31	1-15		0-53		0-50		6-48	19.4		1-15		0-04	0-23	1-17	5	21.5		40.0	

Time Study No 2



the whole crew starts tearing the other unit down and move it up. Coal production stops for two shifts during the move. It requires 14 man-days to make the move and the cost will equal about 9 percent of the total labor cost per ton.

It is interesting to note that a period of just one year occurs between the two time studies. During this time a new tipple was built in which a modern cleaning plant has been installed, an outside haul of about one-half mile eliminated and the entire main motor road relaid with 60-lb. rail on steel ties and slag ballast. It is also interesting to know that at the present time we have attained an average advance of 25 ft. per shift. This gives us an average development of 12½ ft. for each entry. This is an increase of 8 ft. for each entry over the hand loading and just double the advance that was made with the original single set-up that was used at the start.

Vocational Training Among Coal Mine Employes

(*Continued from page* 51)

tional mining education get in touch with the State Board of Vocational Education and see if there are not some funds for trade and industry which could be used for mining and which are not so used.

Mention has been made of the success of the night school men in passing the state examination for certificates of competency. Personally, I attribute considerable of the success in West Virginia and in Maryland in the night school work to the fact that too much emphasis is not placed on the mere passing of these examinations. In other words, these schools that I know of through personal contact, are not schools simply set up to enable the man to get by the examination but they give him a broader knowledge, a knowledge that makes it almost a foregone conclusion that he can pass any state examination, and he is a better mining man for that training.

Those of you who do not know much about vocational work, try to get Dr. Rutledge or Professor Lawall or Professor Nold into a corner and talk to them and I'll venture to say that before you get away from Cincinnati you will be impressed with what they have been doing in the training of men.

After all, that is what this mining educational game is, whether it is college work or vocational work, it is the training of men. One of your jobs as mine executives is to train men to follow along after you leave and pick the men for positions of leadership.

I might say that I took a great personal pride in this morning's session because some of the men who have spoken have been men with whom I have had something to do. Professor Lawall was with me in West Virginia. Mr. Hutson in charge of the work in Maryland, was a mining extension man, to whom we gave his first mining extension instruction and later we put him on the staff at West Virginia. One of our Illinois graduates, as Dr. Rutledge said, was with him, and another one was in vocational mining work in Ohio. I felt a great personal satisfaction at hearing of the success of the work this morning because of the men I have known intimately and personally who are helping to carry it along.

CONVEYORS

in Room and Pillar Operations

By Geo. J. Krebs *

A SECTION of number 3 mine of the Reading Iron Company's Somerset Coal Department is operated with conveyors. This mine is near Stoyestown, Somerset County, Pa., on the Somerset and Cambria Branch of the Baltimore & Ohio Railroad. The coal mined is the upper Kittaning, or C Prime bed, varying from 24 to 36 in. in thickness, of excellent quality, free from binders; the bed is practically free from rock rolls and faults and no clay veins are present. The maximum pitch is about 8 percent, with an average of about 3½ percent. The roof is 20 to 30 ft. of very hard sandstone with an overburden of sand-rock, slate, etc., 120 to 250 ft.; the bottom is slate and bony coal 5 to 10 in. thick, under which is 6 ft. of limestone.

In rooms where the coal is loaded into mine cars by hand, the rooms are driven 24 ft. wide and 300 ft. long on 40-ft. centers; the bottom is lifted the width of the track ties to provide sufficient height to enable the storage-battery locomotive to place empty cars at the face and remove the loaded cars; the lifting of this bottom is paid for as room yardage; the room tracks of 36-in. gage are laid with 12-lb. steel tee rails on steel ties. The coal is undercut with a short-wall mining machine by a machine operator and helper who are paid by the ton; the loader drills, shoots, and loads the coal as well as sets the necessary timbers; when all the room coal has been removed the pillar is recovered by the loader. It is necessary to brush roof or top rock in the room-necks for about 12 ft. to provide head room.

In the latter part of November, 1925, we installed the first conveyor. The rooms were driven 40 ft. wide on 60-ft. centers for a distance of 300 ft.; the first crew consisted of 5 men, four at the face and one at the entry to trim the cars; no contract labor was used, but the cutter was made overseer of the unit; we produced about 40 tons per shift with high upkeep charges, which were prohibitive; we then placed a foreman in charge of each unit, with slightly better results; in April, 1927, we contracted on a tonnage basis with one man for each conveyor unit and he supplied the other men for the crew with the results that our tonnage per shift increased from 40 to 65 tons and the upkeep charges were reduced to a minimum; we experienced trouble in removing the ribs and after changing to the present method of leaving the ribs in place, our tonnage increased to 70 tons per conveyor unit per shift. The present recovery is about 85 percent of the bed. When the conveyors were first installed we were taking down top rock in the entries; we are now lifting bottom for height. All entries were 12 ft. wide in the coal and the same width in the rock, but at present in butt entries 18 ft. of coal is removed and only 12 ft. of rock, leaving a 6-ft. bench of rock on the room side of the butt entry; this bench provides an elevated travel way for the equipment from one room to another and the equipment need not be removed from the bench until all the rooms have been worked out; it also provides a suitable place for the power unit of the conveyor; this change expedites the moving and placing of the machinery.

The first conveyor used for entry driving was 100 ft. long. This was increased to 250 ft. as we found the conveyor is moved only one-half as often as we had to move the original one. Only one room is worked at a time off the butt entry since it has been determined that to work several rooms in close proximity causes interference along the haulageway in placing mine cars for loading. Main entries are driven 1,500 ft. apart and pairs of butt entries on 45-ft. centers are turned every 600 ft.; the butt entries are driven on the pitch of the coal bed and to their required lengths before any rooms are turned; the rooms are mined retreating, the first room turned is at or near the face of the butt entry. Rooms are turned on 60 degree and 90 degree angles from the butt entries, and are driven 40 ft. wide on 46-ft. centers, for a distance of 300 ft., leaving ribs of approximately 6 ft. in width which are not recovered. The room necks are 14 ft. wide, and on the fourth cut, or 24 ft. from the butt entry, the room is at its full width; the room is posted on 4-ft. centers and no posts are removed excepting when a fall of roof is desired.

Each room is equipped with a Lorain double-chain, steel "flite" conveyor laid in 6-ft. sections as the room advances to a total length of 300 ft., which is connected in tandem with the loading boom, all of which is driven by a 20-hp. motor through reduction gears at the discharge end of the conveyor; one 25-ft. face conveyor, one 12-in. Coppus Vano blower and 12-in. canvas vent tube, one electric coal drill, one mining machine, and one Brownie hoist with remote control.

The power unit with switchboard is placed in the room-neck. The main conveyor is placed parallel to and 6 ft. from the rib, and discharges the coal into the mine car on the butt entry; the face conveyor is placed parallel to and about 18 in. from the face of the coal with the discharge end over the main conveyor, the coal is loaded onto the face conveyor which discharges it onto the main conveyor. The face is undercut to a depth of 6 ft. by the mining machine, which remains near the face at all times and is moved about without the aid of a truck; undercutting is begun when loading out is about one-third completed, the machine is operated by one man who shovels the bug dust directly onto the face conveyor. Six-foot holes are drilled with an electric drill by two men following closely after the under-cutter, these holes are spaced on 6-ft. centers, rib holes being started about 18 in. from the rib and ending at the rib; each hold is loaded with one stick of 1⅛-in. permissible explosive. Before shooting, a 6-ft. section is added to the main conveyor, and the auxiliary or face conveyor is moved near the face; the main conveyor is reversed and timbers and material are sent in from the entry as needed. A row of posts 4 ft. apart are set 6 ft. from the face along the back of the face conveyor. After the shots have been fired, the Coppus blower which is in the room-neck is again started to remove the smoke and supply the working face with air from the butt entry; when the smoke has been removed from the face the men resume loading coal. The average time required for one cycle is as follows:

Operation	Minutes
Undercutting	35
Drilling, shooting, etc.	15
Lengthening conveyor	20
Loading coal	80
Total	150

The usual performance in the room advancement is to complete 2½ to 3 cycles per shift of 8 hours; at times, four cycles have been completed.

Each room conveyor crew consists of 6 men, five at the face who cut, drill, shoot and load the coal as well as set timbers and move the face conveyor, and the car trimmer at the entry who operates the hoist and the controls on the butt entry.

The haulageway along the butt entry is laid with 40-lb. steel on 36-in. gage; the cars are of 1½-ton capacity and are delivered in trips of 15 to 18 cars to a point in the rear of the loading boom; a Brownie hoist is placed on the butt entry at a point 75 to 80 ft. ahead of the loading boom in the direction the loads are to be moved, with the control near the room-neck for the convenience of the car trimmer, who uses the hoist to shift the trip of empties under the loading boom; this car trimmer also has the controls of the main conveyor and fan; messages from the face are conveyed to him by an electric signal system. A gathering locomotive with a crew of two men serves the three conveyor operations as well as other sections of the mine.

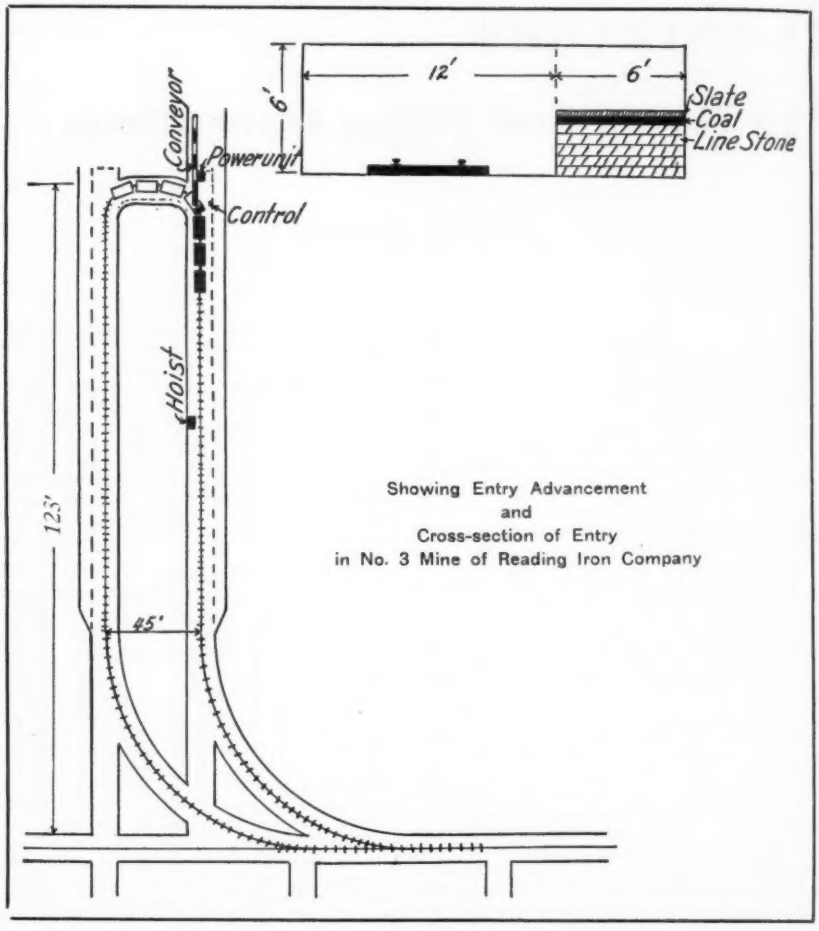
Mine 3 has three room units and each one is averaging 70 tons per shift of 8 hours; the maximum tonnage produced in a single shift by a conveyor unit is 121 tons; the maximum tonnage per shift produced in 24-in. coal is 117 tons.

* Superintendent, Somerset Coal Department, Reading Iron Company.

When the coal in the room has been mined out the equipment is moved to a new room neck in the following manner:

The power end of the face conveyor is placed on the cutter-bar of the mining machine and the mining machine drags it to the butt entry, the average time required for this work is 30 to 45 minutes, and three men of the crew perform the necessary labor; when the machine arrives at the room-neck the face conveyor is removed from the cutter-bar and the machine is dropped to the track in the butt entry, and is then moved to the new working place without the aid of a truck excepting when the move is to be made to another entry, at which time a truck is used; the machine is moved into the new room-neck, and the undercutting of the coal is immediately begun; when the cut is finished, the coal is shot and loaded direct into the mine cars by two of the crew; immediately after the coal is loaded, 8 in. of bottom (which is either bony coal, or slate) is shot and removed to provide height for the power unit. The remaining members of the crew are sending out on the main conveyor to the butt entry all tools, loose props, and equipment which were used at the face; the conveyor boom is loosened by removing the drive chain and boom supports, and is placed at the side of the butt entry; the chain is removed from the main conveyor in 6-ft. lengths by two men pulling it off the sprockets, while a third man operates the control; the time required to remove the 600-ft. chain and place it on piles is 60 to 65 minutes; as soon as the chain is removed, it takes about 5 minutes to separate the power unit from the pans; the first five or six pans of the conveyor are removed and piled in the room-neck; then the hoist rope is fastened to the conveyor and the entire pan section is dragged down the room to the butt entry; five or six pans are removed each time until the entire pan section is separated and piled, requiring from 60 to 75 minutes to complete the operation. The hoist is now moved by its own power to a new position consuming about 25 minutes; the hoist rope is attached to the power unit and it is pulled onto the butt entry track, thence on the track to the new room-neck, it is then pulled onto the room-neck bench by the power of the mining machine, requiring about 30 minutes for the move; the boom is attached to the power unit and the boom support placed in the entry requiring about 25 minutes; the tail piece and chain are placed in position in about 30 minutes and the new room is ready for its second cut. The changing of the equipment from one room to another requires 3 to 5 hours where the conveyor crew prepare their own place. The usual practice is to move the equipment from the worked-out room to the new place and load 20 to 35 tons in a shift of 8 hours. At times the place is prepared in advance by the crew, at which time they do not remove all the pans from the worked-out room on the first day, but one of the crew will remove and drag to the new working face sufficient pans each day. There have been times that the height in the entry would permit the power unit with the boom attached, to be loaded into a car and moved to the new working face, which saved considerable time and labor.

The nature of the roof permits the extraction of the coal from three or four rooms before it is necessary to leave a rib of about 6 ft. standing for protection; the room stumps and chain pillars



Showing Entry Advancement
and
Cross-section of Entry
in No. 3 Mine of Reading Iron Company

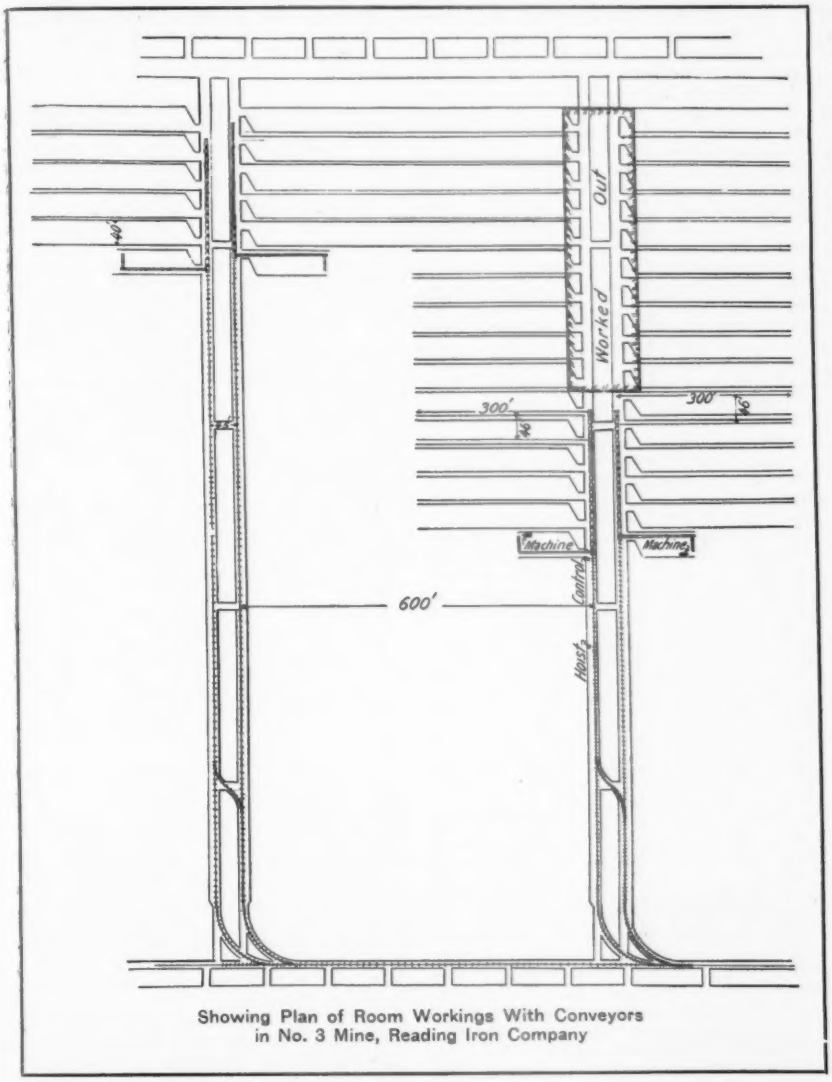
are left standing along the butt entries for sufficient distance to furnish standing space for the required number of cars (15 to 18) for a distance of 200 ft., these chain pillars and room stumps are recovered by open end work by four pick men following the extraction of the room coal; the first fall of roof generally occurs after about 200 ft. of the stumps have been removed; the roof generally gives sufficient warning before it falls to enable the removal of all material used in that particular work; at times it is necessary to remove timbers to obtain a fall of roof.

Main entries are driven 12 ft. wide in the coal and the same width in the rock, while butt entries are driven 18 ft. wide in the coal and 12 ft. wide in the rock, leaving the 6-ft. rock bench on the room side. In all entries the height of 5 ft. above the rails is obtained by lifting 36 to 42 in. of limestone.

The entry driving equipment is the same as that used in the rooms, excepting that no face conveyor is used; the conveyor crew consists of three men at the face and the car trimmer at the loading boom. The method of producing coal is the same as in the rooms excepting that the coal is shoveled direct onto a main conveyor instead of a face conveyor; at times it requires double shovelling; the loading boom is placed opposite the last cut-through in the butt entry and is supported at the discharge end by a rail being placed across the entry at a height that will permit the mine cars to travel under it; a locomotive pushes a sufficient number of cars to load out a cut under the loading boom and through the cut-through into the parallel butt entry and these cars are shifted under the loading boom for loading, with a Brownie hoist by the car trimmer. The maximum number of cycles performed by an entry crew is four and the average number of cycles is three; the maximum tonnage per shift for an entry crew is 58 tons, while the average tonnage is 36 tons. The entry conveyor is working two shifts of 8 hours to the shift and the maximum distance driven per shift is 28 ft., while the average is 21 ft.; each conveyor unit drives three pairs of butt entries.

Moving and resetting the entry unit is practically the same as that of moving and resetting the room unit excepting that flat trucks with 6-in. wheels are used to transport the power unit of the entry conveyor.

When the coal has been removed from 250 ft. of entry, the conveyor unit is moved to another entry and the rock is lifted by a rock crew of three men who contract to drill, shoot, and load the rock into mine cars at a fixed price per foot of completed entry; the method used is to drill (with a pneumatic jackhammer drill, with power furnished by a portable air compressor) a 10-ft. center hole starting within 5 in. of the floor and ending at the floor; this hole is charged with eight 1¼ by 8-in. sticks of permissible explosive and after being properly



Showing Plan of Room Workings With Conveyors in No. 3 Mine, Reading Iron Company

tamped is fired with an electric detonator. The average time required to drill, charge and shoot a 10-ft. hole is about one hour. This practice of drilling only a center hole makes it necessary at times to shoot an occasional bump hole to provide the proper entry width; the time required to drill, charge and shoot the average bump hole is about 15 to 20 minutes and the work is done by one man of the crew, while the other per shift is three, or 30 ft., while the average is two or 20 ft. In January and February of 1930, a crew consisting of three men worked 42 2/3 shifts and advanced 884 ft. of rock, or an average of 20.7 ft. per shift, or 6.9 ft. per man-shift. Rock cannot be transported by a conmen are loading rock in a parallel entry; the rock is worked in two entries by one crew; the maximum number of clean-ups veyor from the rock face to the car as the conveyor is on the rock ledge about 42 in. above the floor which would necessitate the raising of large pieces of limestone to a height of 54 in. to get them into the conveyor.

It is difficult to obtain two crews that will work in harmony which necessitates each crew to clean up the face before finishing the shift; this condition interferes with obtaining the desired number of cycles per shift; the average for each conveyor on single shift is 70 tons, while the average per unit for double shift is 50 tons; double shifting requires additional foreman, labor and mine cars.

In rooms where conveyors are used, there are no tracks and no bottom is lifted, thereby saving yardage cost, time of lifting bottom, and cost of storage-battery locomotive operation. Bottom rock, or limestone cannot be taken for height in entries from which rooms are driven for hand loading into cars; in entries where bottom rock, or limestone is taken for height, the only preparation necessary in the room-necks to receive the power unit is the lifting of about 6 sq. ft. of bottom 8 in. thick, a great saving over the necessary preparation of the room-neck in the entries where top rock is removed. A room operated with conveyors will produce during each working shift a tonnage equal to that which would ordinarily be mined from five rooms with hand loading into mine cars; the conveyor crews are loading nearly 12 tons per man-shift of better prepared and coal with more lumps than the miners who are hand loading into cars 6 to 8 tons of coal which has been cut for them by a machine operator. Mechanized loading shows marked decrease in accidents as compared with hand loading.

Within a few months, mine 3 will be entirely mechanized and we will then increase the height and with of the mine cars sufficiently to give them a capacity of 2½ to 3 tons as they will remain on the entry at all times, while at present, cars are placed in rooms to supply the hand loaders and owing to the lowness of the coal bed we can use a car of no greater height than 25 in. If mine 3 were entirely mechanized it would be possible to produce 550 to 600 tons per shift with only seven working places.

DISCUSSION

Conveyors in Room and Pillar Operations

M. D. Cooper, *division general superintendent, Hillman Coal & Coke Company:*

In the management of these meetings the desire to save time in having the authors condense their papers deprives us of the opportunity to get the full good out of the contributions, and especially this very interesting and straightforward explanation that Mr. Krebs has given. His paper is an exceedingly valuable contribution and should be read in its entirety in order to obtain the full information that he has presented.

Mr. Krebs is doing a pioneer work. The use of face and room conveyors has been so successful in his mine and in an adjoining plant, that it seems altogether within reason to predict that the time is coming when conveyors will be used in the butt, or mining entries, and in the rooms, and that the mine cars may not leave the main entries. In other words, all of the transportation of the coal from the face to the main entries may be accomplished by means of conveyors.

In the Jerome mine, near the mine operated under the supervision of Mr. Krebs, similar equipment has been installed with altogether comparable methods of operation and results. This equipment was installed by Messrs. F. B. Dunbar, E. A. Siemon, and Edward Ryan, and is being operated under the supervision of Mr. Siemon and Mr. Ryan. The costs that were given by Mr. Affelder and the charts that were shown on the screen were based upon the operations of the machines at Jerome.

There is one distinct difference in the Jerome system as compared to the system under the supervision of Mr. Krebs. That is that the rooms are driven on 60-ft. centers instead of 4 6-ft. centers. The rooms themselves are 35-ft. wide and

therefore the ribs are 25-ft. wide. Instead of leaving a 6-ft. pillar between the rooms the Jerome system calls for the complete extraction of the rib.

Mr. Krebs has told us that he moves the machines from one room to another in from three to five hours, an excellent record. This raises the question which Mr. Krebs may be willing to answer for us, whether the cost of extra equipment would be justified so that no time would be lost between the finish of one place and the start of another? It also would be interesting to have Mr. Krebs tell us whether the leaving of the 6-ft. rib between the 40-ft. rooms causes any embarrassment in the matter of carrying weight over to the place in current operation.

Also, we would be interested, I am sure, to know whether the system as followed by Mr. Krebs is on a double shift basis or single shift. In that connection, he might tell us whether it would be possible to work it on a triple shift basis so that the mine could start on Monday morning and work through until Saturday night on a continuous operation.

L. H. Schnerr, *division manager, The Consolidation Coal Company:*

To explain my discussion of Mr. Krebs' paper, I wish to state that I have been requested to give the methods of working and some experiences encountered at our Gray operation.

At Gray, which is within six miles of the Reading mine, The Consolidation Coal Company operates a 100 percent conveyor mine. However, while the Reading Mine is in the C Prime seam our mine at Gray is in the seam above, known as the "E" or Upper Freeport.

The portion of the "E" seam mined as marketable coal is 34 in. Immediately above this portion of the seam are eight in. of bone which requires many more timbers to keep in place than does the sand rock encountered in the Reading Mine. We usually set the timbers on 4-ft. centers with the rows on 3-ft. centers. Above this bone, we find 6 to 18 ft. of gray slate and 30 to 50 ft. of Mahoning sandstone. The total overburden ranges from 200 to 400 ft.

Immediately below the 34-in. coal seam is a 1½-in. hard bone parting, followed by 4½ in. of good coal, another ¼ in. of hard bone parting and 9 in. of dirty coal. The real bottom is a hard slate.

In our rooms we cut out the upper binder, which is just below the marketable coal, and gob the cuttings. The same is true for the cutting in the air courses and cross-cuts. In the hauliage entries, and wherever brushing is done, the cutting is in the bottom bench of coal and the cuttings are loaded out as refuse. The gobbing of cuttings, or in the case of haulage entries, loading the cuttings as refuse, is quite a handicap on big tonnage records. It means further that the operations must be more distinct so that these cuttings will not be mixed with the coal. The advantages are greater height and better sized coal.

Our system of driving rooms is called the single room system. Only one room is driven on any one butt heading. The rooms are on 50-ft. centers, giving a 40-ft. room and a 10-ft. pillar. In this system one main conveyor with a loading boom and one face conveyor are used. When the room has been driven to the limit, which is usually 300 ft., the face conveyor is removed and 40-ft. slabs are cut out of the theoretical 10-ft. pillar. Actually this pillar is seldom over 8 ft. in width and so when a 7-ft. cut is removed, nothing but a shell remains to keep out the adjoining gob. The pillar is extracted very quickly, and a pillar once started is carried to completion without delay. The main conveyor into which the pillar coal is loaded directly is shortened after each cut is removed. It takes three men approximately three hours to move the main conveyor from the finished room to the next room neck in which two cuts have been previously removed and the third cut made. From the time the coal stops coming from any given room until the coal begins coming from the next room neck is therefore slightly over three hours. Of course there is a slight delay when the face conveyor is installed and when it is removed, these times being different than when the main conveyor is moved. Usually it requires about one and one half hours for four men to either place or remove the face conveyor.

The standard room crew consists of five men, including the leader, who is invariably the machine man or cutter. The practice at the present time is for a crew to load out two cuts one day and three the next, the average therefore being five cuts per day of two shifts. We have loaded out six cuts in one day of two shifts. The maximum tonnage has been 88 tons in one shift.

A time study in room work has given the following results:

Cutting including the gobbing of cuttings	18%
Drilling and shooting	11%
Timbers	8%
Moving face conveyor, extending main conveyor and inspecting the chain after each cut	17%
Loading	46%

You will note that the actual loading of the coal takes a little less than half of the total time expended. The preparation of the place including the shooting is the largest part of the working cycle.

In entry driving, the haulageway and air course are driven at the same time with one common loading point. In this set-up two 300-ft. conveyors are used, one in the middle of the 16-ft. air course and the second on the chain pillar side of the 12-ft. haulageway, both discharging on a cross conveyor furnished with a loading boom and located in a crosscut.

We drive both places 300 ft. beyond the loading point, when the loading point is advanced 200 ft. or to the second crosscut. This method gives us a minimum storage space for empties of 100 ft. and a maximum of 300 ft.

When the cut is made in the bottom bench on the haulageway, the cuttings are loaded out as refuse and the coal shot down. The 34-in. portion of the seam of clean coal is then loaded off the top binder. When this coal is loaded out completely, everything from the top binder to the real bottom is loaded and discarded. A few cuts behind, the top bone is either pulled or shot down and loaded out giving a clear height of almost 5-ft. The setting of a few timbers act as a breaker row so that the top bone does not fall on the conveyor.

Our method of driving entries compels us to brush but one entry and no crosscuts. Only when a side track is to be made in the middle of a panel do we deviate from this rule. The track is laid by regular track men as the place advances.

The regular entry crew consists of a total of five men for two places. Our average advance is approximately two cuts in each place per shift. We have made as high as three cuts in one shift, removing everything except the top bone in the haulageway.

It has been found economical to work but two shifts per day. The machinery does not get the necessary attention when the third shift is added. Furthermore when the third shift is added, the tendency is to make only temporary repairs and then only absolutely necessary to run coal.

Although these remarks do not apply directly to Mr. Krebs' paper, nevertheless they are closely related to his subject.

Long Wall and Long Face Mining Methods

being tried in Oklahoma Fields

By Earl H. McAlpine *

OF the methods of long wall and long face mining methods in use in Oklahoma mines at this time I shall outline four in this paper.

Two of these methods are in use in mines which are comparatively level and two are in mines with steep pitching coal. The first of these is used in the Kali-Inla mine near Hartshorne. The second is in the Milby-Dow Coal Company mine at Dow. The Mullen Coal Company near McAlester and the Hailey-Ola Company mine near Lutie, are steep pitching mines.

Last year Mr. Franklin Bache, presented a paper before the American Mining Congress which explained in detail the long face operations in the Kali-Inla mine. This is a complete caving system with rigid roof support, a roof break being induced after every cut, by means of collapsible cast steel props, known as "jacks," with no supporting timbers or cribs of any kind in use on the face. Coal is hand-loaded on a reciprocating conveyor. Within the past year there has been developed a modified system for use under bad top. The system as explained by Mr. Bache involves loading over the side of the conveyor throughout its entire length, and moving it up towards the face as a complete unit after the shooting and loading of each cut.

Under the old system coal loading had to be stopped when it was necessary to load rock because the conveyor was being loaded from the side along its entire length. Obviously coal and rock could not be placed on the conveyor at the same time.

Under the old system the supported span between solid coal and the first row of jacks was 9 ft. wide by 300 ft. long, a total area of 2,700 sq. ft. Under draw slate or local bad top considerable trouble was encountered and heavy expense incurred due to the fact that all coal had to be removed from the conveyor before any rock could be loaded.

Now when the face encounters bad top the machine sumps in at the lower end, cuts up the wall 25 or 30 ft. This coal is shot down and loaded on the conveyor from the side. Then the conveyor is moved into the space just cleared of coal. After the conveyor is placed and the jacks are set, the machine cuts for 4 or 5 ft. and is stopped. Jacks are set as close to the undercut coal as possible and kept 3 ft. from the solid rib. This coal is shot down and loaded on the conveyor by two men while the machine cuts another distance of 4 or 5 ft.; the jacks are advanced and the cycle repeated as before. A short pan is used to keep the conveyor at a minimum distance from the coal.

The net result of this modification of the working cycle has been to reduce the total unsupported roof area to 50 sq. ft. or a span of 10 ft. for a distance of 5 ft. along the face. If it is found necessary to take down some of the bad roof, this can be loaded immediately as the rock will be loaded on the end of the conveyor without waiting for all coal to be removed. The rock can be loaded into a separate car at the lower end of the conveyor without the necessity of hand picking.

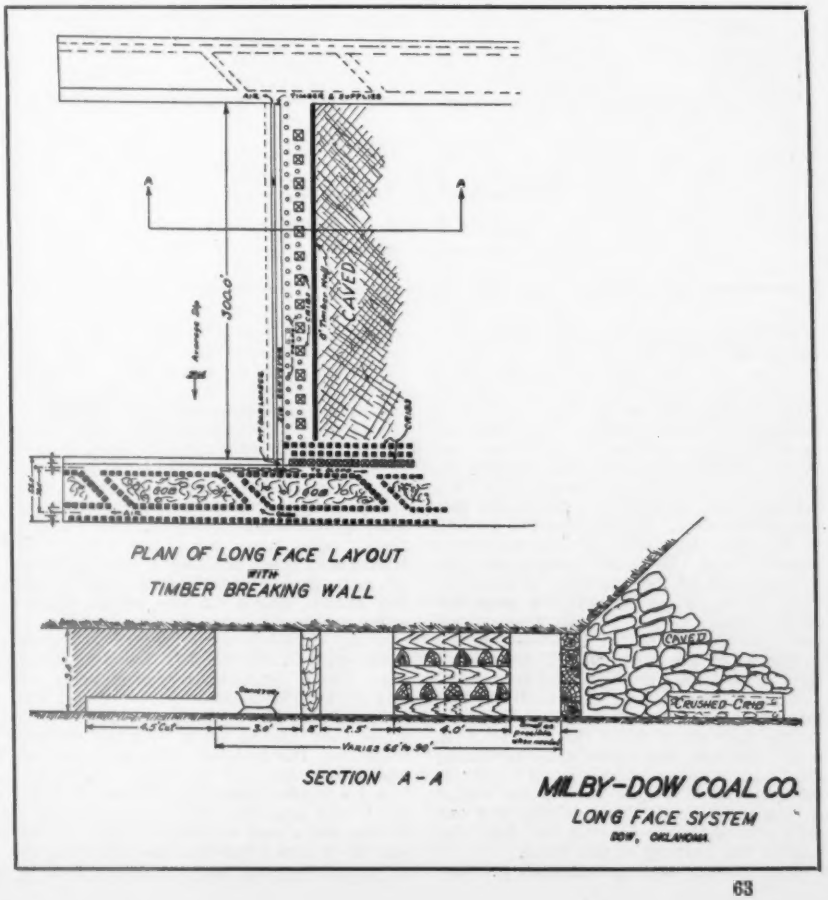
It has been found that this method greatly reduces the amount of rock to be loaded and that less time is lost per car of rock loaded. It has been possible to advance this face under bad top, as much as 60 to 65 ft. in an 8-hour shift with a crew of eight men. This gives 60 to 65 tons of coal or 7½ to 8 tons per man employed at the face.

The Milby and Dow System

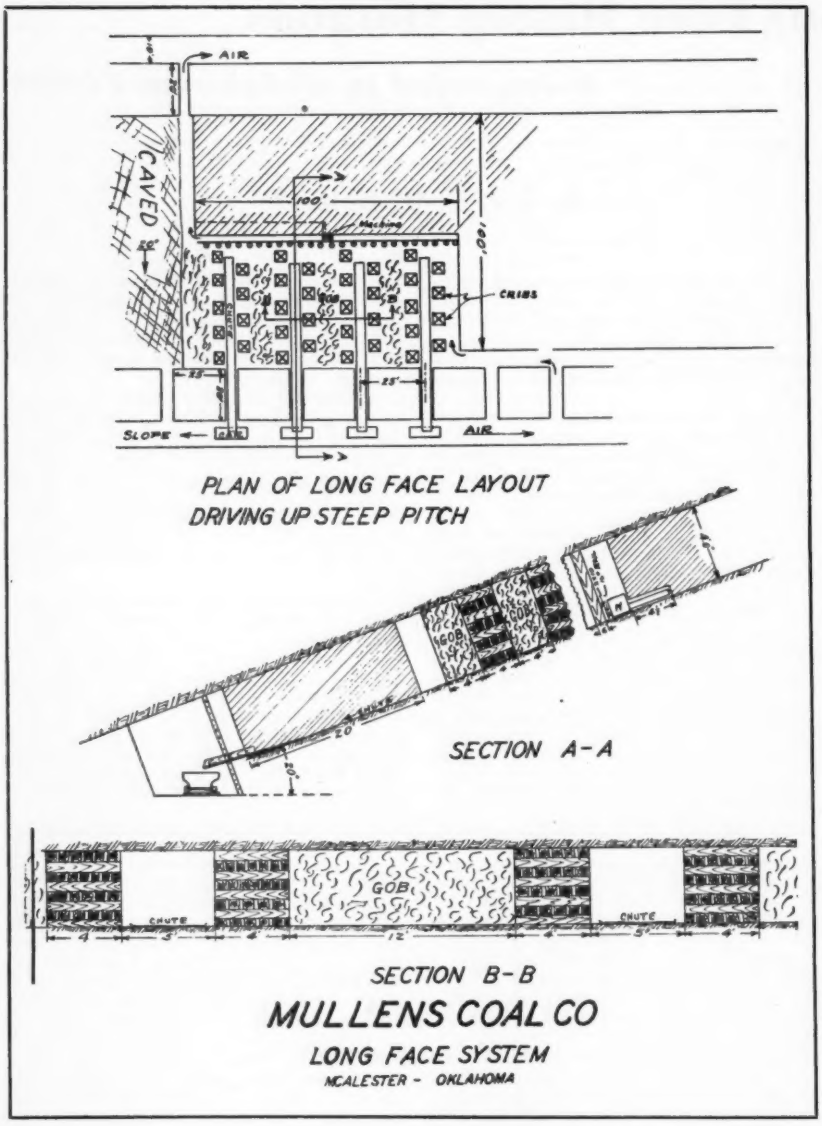
This might be described as an intermittent caving system, with non-rigid roof support except at the time of inducing a break. The No. 9 mine of this company is in the McAlester seam, which is uniformly 2 ft. 10 in. thick and dips 7 degrees to 11 degrees. The top is good for a time after the coal has been taken out but after it has been exposed to the air for some time and a little weight comes on, it has a decided tendency to break into small pieces. This causes the haulage ways to appear ragged but very little trouble is experienced with fallen rock on haulage roads.

At the bottom of a 600-ft. shaft two slopes are driven on the dip of the seam. At 350 ft. intervals on these slopes, entries are driven on 1 percent grades favoring the loads. This mine uses animal haulage except on the main entry approaching the shaft bottom. A parallel connection is driven 300 ft. distant from the slope, and a face is started from the inside rib.

The entries are driven 55 ft. wide and have two haulage ways on 38-ft. centers each brushed to a height of 7 ft. This allows about 18 in. for settling of the top and heaving of the fire clay bottom. It is necessary to brush the top because when the bottom is once broken it will crumble badly. Bottom brushing was tried on one entry. The bottom crumbled under the cribs that were supporting the upper side of the entry and caused the



* Mining Engineer, Haileyville, Okla.



whole entry to cave in after it had been advanced about 200 ft.

When the day shift comes off at 4 o'clock, three machine men are ready to start cutting the wall. This is usually finished at 7 o'clock when seven men go on to drill the face and to move the conveyor. While three men are drilling the wall, four others are dismantling the conveyor and laying the pans to the side nearest the face. By the time the drilling is finished the conveyor has been dismantled and the seven men move the driving unit of the conveyor toward the face. It is so placed that the pans are within about 6 ins. of the undermined coal. A pit car loader is placed at the discharge of the conveyor. The pans are then moved into position and connected.

A shot firer follows this shift of men and shoots the entire wall.

The day shift finds the conveyor in place, the coal shot down and everything ready to begin loading. Each loader is assigned 40 ft. of the face to be loaded as his day's work. Two drivers and one man attend to the loading and haul the coal to the parting at the slope.

Four timber men go on with the day shift. Their first duty is to build three cribs at the lower end of the wall immediately outby the lower end of the conveyor. The first crib is of 6-ft. timbers hewn on two sides, with five timbers to the layer. This crib is filled with rock. Three feet above this crib another one is built of timber only. It is of 6 in. x 8 in. x 4 ft. timber, laid solid. A similar crib is built above this and just outby the driving unit of the conveyor. When these three cribs have been completed the timbermen start building a row of cribs of split timber on 15-ft. centers along the entire length of the wall. These cribs are not filled. As the loading is nearing completion timbermen set split props on 8-ft. centers 3 ft. from the solid rib. These timbers are not capable of any great resistance to pressure and are used only for the protection of the miners while they are at work. As the weight comes on, the unfilled cribs are crushed and allow the roof to settle gradually. The foreman of each crew keeps a lookout to the area that has been mined out. If the cribs and timbers in the second and third row from the face show signs of failure he stops any operation that is going on and builds a solid timber wall of 6 in. x 8 in. x 4 ft. blocks as near the conveyor as possible. These timbers are laid with the length parallel to the face. It has been found that this wall will break the top at this place and cause no trouble at the working face. A short time ago this wall was built during the day shift and no loading time was lost. In one or two instances only a short section of this wall was built and effectively stopped a threatened break.

Since this method has been in use, there has not been a shift lost due to caving at the face. Prior to this a heavy break would come when the face had advanced 65 to 100 ft. from the starting point. This would necessitate the driving of another place through to the entry above and often a part of the conveyor had to be taken from under the fall. In one or two instances the machine was also covered.

Each cycle produces 150 tons of coal. This is about 6½ tons per man employed at the face.

The Mullen Coal Company System

In the Mullen Coal Company mine no attempt is made to cave the roof at a definite place. An area has been determined under which it is practical to work. This area is then mined out and abandoned. The roof is supported, only for the time necessary to complete a section, by straight props and cribs.

The Mullen Coal Company is in the McAlester seam. The coal at this place is 4 ft. thick and dips 20 degrees to the south. There is a layer of draw slate and bone above the coal which varies from 2 to 8 ins. in thickness. Above the draw slate the top is too bad to be worked successfully by room and pillar method because the rooms had to be kept open too long. By working a long face the section can be mined out and abandoned before the roof gives any trouble.

At 150-ft. intervals on the slope a pair of entries are driven on the strike of the seam. These entries have a 25-ft. pillar left between them, and are connected at 25-ft. intervals by a crosscut. The lower one is brushed for a haulage way. The upper entry is used only as an air way.

The practical length face for this mine is 100 ft. The length is along the strike of the seam and the face is driven up the pitch. A 250-ft. pillar is left to protect the slope. Beginning just past the end of this pillar the first face if started.

A row of timbers is securely set 30 ins. from the upper rib of the air way. A row of 2 in. x 10 in. boards, with a 16-lb. rail bolted along the center, is placed on the upper side of these props, to hold the mining machine to the face while it is cutting.

The machine sumps in at one and cuts along the strike of the seam to the opposite end of the face. As the machine advances the coal breaks down of its own weight. The corners require a light shot. Otherwise no explosives are used on the face. This is a very desirable thing as the coal is soft and is easily made into slack by shooting.

Chutes are made from the haulage entry to the face, through the crosscuts, by laying galvanized metal sheets on the bottom and fastening them to the bottom with nails. These chutes are kept within a few feet of the face. All chutes are protected by a row of cribs on 10-ft. centers staggered on either side.

Two miners start behind the machine to break the large lumps that have fallen from the wall and place the coal in the chutes. When the machine men have

finished cutting they help the two miners break the coal and put it in the chutes.

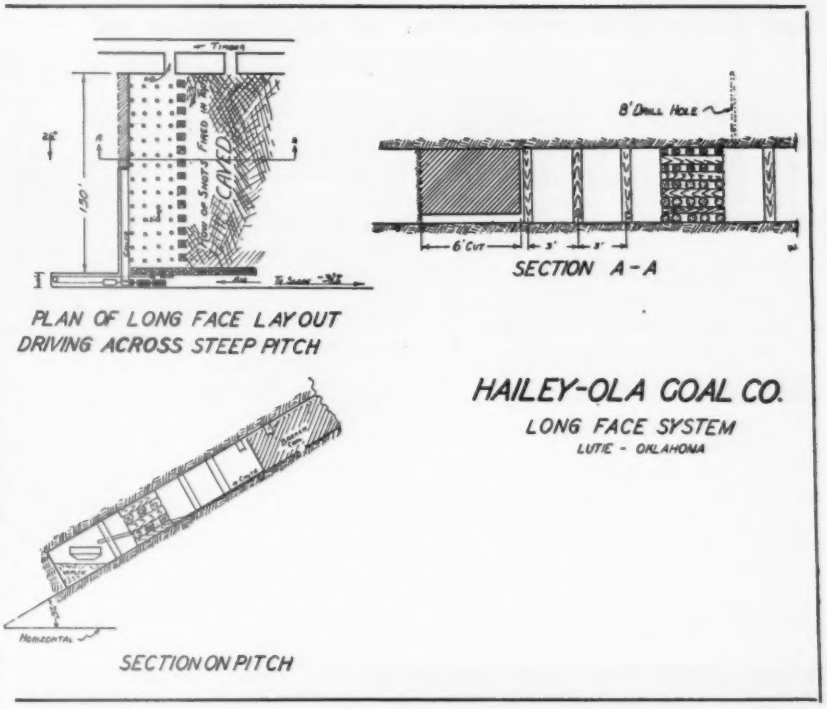
The driver loads the cars from the chutes on the haulage way. The chute is kept partly filled with coal to avoid breakage due to coal rushing down an empty chute and striking the car or other coal at the lower end.

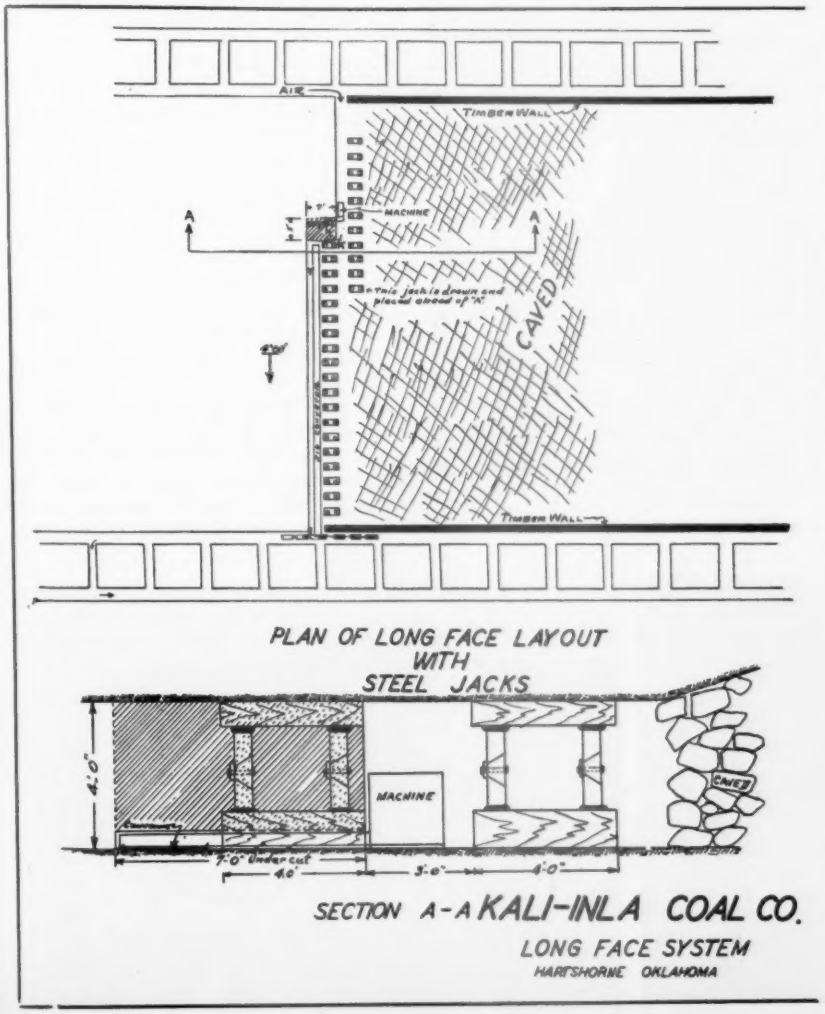
This face is driven up the pitch about 100 ft. before any trouble is experienced with the roof. As soon as the roof begins to give trouble the equipment is taken out and the face is abandoned. A hole is driven through to the entry above for ventilation if the top does not get too bad to get through.

The only timber used on the face, in addition to the row of cribs on each side of the chute, are the timbers that are set as a guide for the machine.

Very little of the coal has to be handled over a great distance. The cutting and loading is completed on a 100-ft. face by a crew of five men, including the driver, in eight hours. When the face is worked every day a section is mined out in 25 days. Each cut produces 55 tons of coal which is 11 tons per man. As each section is worked out the machine is taken to a new position just outby the one that has just been abandoned. This face is advanced along the one just worked out. No pillar is left between them.

It is the present plan of the company to drive two pairs of entries to the boundary and retreat with a series of these





faces. It is believed that by removing the pillar between the entries, as part of the face, 100 percent recovery can be obtained with this system.

The Hailey-Ola Long Face System

This is a non-caving system with semi-rigid support, the roof being held up by timbers until the face squeezes, when it is abandoned and a new face started.

The Hailey-Ola Coal Company's mine No. 5 is in the lower Hartshorne seam. The coal has a normal thickness of 5 ft. There are no dirt bands and the bottom is very hard, making it necessary to cut in the coal. The pitch varies from 37 degrees at the outcrop to 25 degrees at the 11 level. The coal is very brittle and every precaution is taken to avoid unnecessary degredation. The top is a gray slate and is considered brittle. It causes very little trouble at the time the coal is taken out. Breaks are hard to control and considerable trouble has been experienced in this way.

The entries are turned to right and left of the main slope at intervals of 180 ft. These are driven on 3½ percent grade favoring the loads. The empty cars are pulled to the loading place with a rope and the loads run to the parting at the slope by gravity. No brushing is taken. Track is laid on waste built up on lower side of the entry.

The most practical length of wall is 150 ft. This can be cleaned up in an eight-hour shift by eight men. A night crew of three men cut and timber the wall. The machine sumps in at the lower end of the wall and cuts up the pitch. Machine cuttings are thrown into the gob as there is very little market for screenings in this field.

The cutting is done in three hours. After the wall is finished the machine cuts the entry heading which is kept about 50 ft. in advance of the wall. The coal is undercut to a depth of 6 ft. A timberman follows the machine up the wall, setting props 4 ft. apart and as close

(*Continued on page 74*)

LONGWALL MINING *at the mines of the* Pruden Coal & Coke Company

By Charles A. Griffith *

Charles A. Griffith

REALIZING rather distressed conditions of the coal business in so far as profits are concerned, and that from year to year competitive conditions are becoming more severe, we decided to investigate a more modern method of mining as compared to the room and pillar system.

Due to the fact that our coal has a parting, we found mechanical loaders impractical without the use of a coal-cleaning plant on the outside. We therefore decided that we might possibly be able to use the longwall system, provided we loaded our coal by hand into conveyors. About a year ago, our superintendents and I visited the Moffett and Montevallo plants in the vicinity of Birmingham, Ala., where they were using the longwall system of mining on a slope of about 15 to 20 degrees. These companies very courteously took us through their mines and explained in detail just how they were progressing with the longwall system of mining. Upon our return to our mines at Pruden, Tenn., we decided to try out the system of longwall mining, but, on account of our mine being practically level, it was necessary for us to use a type of conveyor other than the one used at the Alabama operations. We purchased from the Conveyor Sales Company of New York City one conveyor drive and 400 ft. of troughing together with one duckbill.

* Vice President and General Manager, Pruden Coal & Coke Company, Pruden, Tenn.

Discharge end of conveyor and drive are shown above.

In testing out this conveyor we thought it best to use it first in entry work so as to familiarize ourselves with the working of the conveyor. We had 525 ft. of entry to drive through a fault to connect up our main haul with the main part of the mine. We made very good progress with this work, taking two cuts each eight-hour shift with three men on the duckbill and two men on the motor crew. We completed the 525 ft. of entry in about 40 working days. The bottom bench of the coal in this entry was 36 in. The top or parting was taken to the top bench of coal, which varied in thickness from 40 in. to 96 in.

A jack hammer was used for drilling both coal and top. When this work was completed, we had prepared a 150-ft. wall as shown on *Figure 1*, Wall No. 1. We had not fully decided what method we would adopt to control the roof, but realized that we would have to resort to some mechanical means in the way

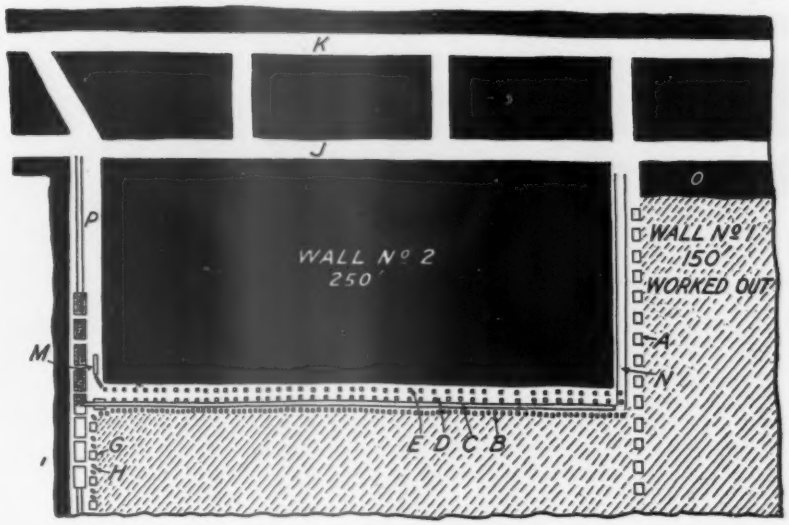


FIGURE 1

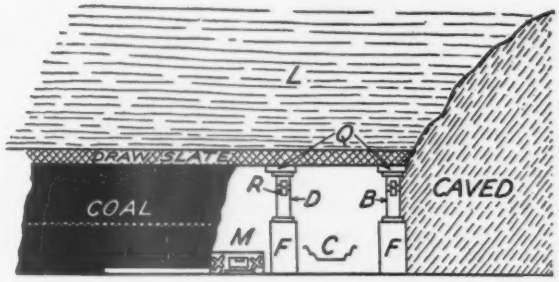


FIGURE 2

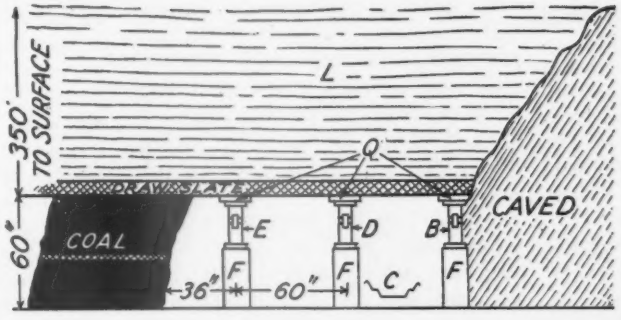


FIGURE 3

of jacks. However, we decided to start the wall and use cribs until we got our initial fall. This occurred when we had advanced the wall 65 ft. We were carrying two rows of cribs, 5 ft. on centers and 13 ft. between cribs in rows, using 8 x 8 timber 36 in. long, building cribs square. When the initial fall occurred on account of the centers of cribs in rows being too great, the top rode in between the cribs, which caused us to lose about 60 ft. of wall. (We had anticipated this fall and had moved the conveyor pans.) From the remaining 90 ft. of face, we took out three cuts next to roadway "N" with longwall machine. The other 60 ft. of wall was pushed up by using a short-wall machine, placing cribs the proper distance from face to start wall again. After we had reestablished the face, we placed our cribs 6 ft. on centers, using one row only. We learned from this that we could break our roof, but we found it entirely too expensive to remove the cribs, so we decided to shut the work down until we could order mechanical jacks. Not knowing the best type of jacks to use, we purchased some of the Arkansas sand jacks from the Engineering Works, Van Buren, Ark., which are in sections and can be made any height. We also purchased some of the Langham jacks from the Lorain Steel Company. As soon as the jacks arrived, we com-

Photographs of jacks and conveyor in positions described in Figs. 2 and 3

menced to operate our wall again. We placed two rows of jacks as shown by *Figure 2*, removing our cribs. This was done by shooting, usually two timbers in each crib. After we commenced with jacks, everything moved along very nicely. This wall was finished up to within 15 ft. of air course "J," leaving a pillar 15 ft. thick, "O." The breaker row of jacks "B" are set 30 in. on centers. Row of jacks "E" are set as soon as the cut is loaded out sufficiently for these jacks to be placed, which means 36 in. from back of cut. Mine cars are loaded on roadway "P" by elevating end of conveyor sufficiently to permit cars to pass under end of same. Longwall machine "M" is left at corner of wall in roadway "P" when cut is finished.

Figure 2 shows position of jacks B and D, also mining machine "M" cutting face. You will notice that roof "L" breaks off at breaker row "B," as shown in the caved section. This occurs after each cut as jacks are moved over.

Figure 3 shows a section of face after cut has been cleaned up and conveyor "C" ready to be moved over into new position between rows E and D. When this is done, row B is moved and the usual roof cave occurs. When we are able to hold draw slate up, we find that seven men can load out 250 ft. of wall in an eight-hour shift. On account of it being rather hard to get good men for this type of work, so far we have only used one crew, loading out coal in one shift and moving jacks and conveyor in the other shift. When we have not any trouble with draw slate, we find that the moving shift can do their work in less time than the loading out of the coal, but, of course, if we have trouble with draw slate, of which we have had quite a bit, we find that both loading and moving over takes considerable more time.

We have experimented with all sizes and thicknesses of capboard "Q," but find about the best capboard is some hard wood, such as beech, sawed 12 in. wide by 14 in. long, thickness varying from ½ in. to 6 in. By having the various thicknesses, we are able to get the proper thickness of cap, so that the Langham jacks are tightened by drawing in wedge "R." The length of our Langham jack is 26 in. with 10 x 10 head and base set on wood block "F," which can either be round or square, sawed from beech, gum, hickory, or any other hard wood. We find that timber "F" will not be damaged any whatever when jacks compress capboard "Q," possibly one-third the original thickness. Timber "F" is sawed 30 in. long with staple driven near top of same, so that when jack is discharged hooks can be inserted to pull timbers from the gob. We are doing this work entirely by day work, and we find that the average miner, after he has worked on the longwall for something like a week, makes a very satisfactory man. Of course, for the first few days he is dubious of the top falling and on account of the capboard popping, etc., however after a few weeks' work, the miners pay no attention whatever to the roof caves, because they have learned to have confidence in the jacks. Occasionally we have a jack in the breaker row to be discharged, due to a large piece of roof sliding down and striking same, but on no occasion have we had more than two jacks discharged at one point. The discharge of one jack has very little effect on the roof at that point. When the face is cut, the coal sets down from one end of the face to the other. Up to the present, we have not had to fire a single shot either in Wall No. 1 or No. 2.

As I stated in the beginning, our experience with the longwall system of mining is somewhat limited, due to the fact that we have been trying out this system for about nine months. We believe after our experience at our own mines, and judging from our inspection of other operations, that the question of control of roof, after all, is more or less experimental and varies with each operation. We are fully convinced, however, that there are many advantages to be had from longwall mining, such as the loading of larger sizes of coal, the concentration of work, better supervision resulting in cleaner coal and fewer accidents, the reduction of cost of haulage due to fewer mine cars, less track and trolley wire required.

Developments and Operations with MECHANICAL LOADING

By T. J. Thomas *

THE Valier mine was sunk as a railroad protection measure growing out of the World War. It was laid out on a large scale capable of producing 8,600 tons per day. During the development period there was an urgent demand for coal, with the result that we were unable to make a satisfactory gain in our advance work, all of which operated to increase production cost. Meanwhile, the cost of coal to the purchaser steadily increased so that the railroads, along with other large users of coal, addressed themselves to the matter of fuel consumption, and the means that might be employed to bring about greater efficiency. Our laboratory was delegated to approach the matter from a scientific point of view, in addition to which practical and technical men from our mechanical and engineering departments were called upon to study the situation and make such investigations and tests as, in their judgment, were necessary. Our research work, and that done by other companies, developed many interesting factors from the standpoint of combustion, and where the economics were sound the improved methods and facilities recommended (a few of which are here listed) were adopted:

1. Increased tractive power and the purchase of improved locomotives where necessary to replace those retired.
2. Conversion of locomotives from saturated to superheated steam.
3. Water treatment.
4. Improved method of hand firing.
5. Grates of improved design and increased area.
6. Feed-water heaters.
7. Increased standards of maintenance.
8. Automatic fire doors.
9. Automatic stokers.
10. Automatic signals.
11. Grade reductions.

The results achieved were gratifying, and while it is not my purpose to burden you with statistical data, you will be interested to know that in 1920 the Burlington Railroad consumed 177 pounds of coal per 1,000 tons of freight moved 1 mile, whereas in 1929 we consumed only 126 pounds, a decrease of 28.8 percent. In order that you may have a more graphic picture of just what this reduction meant, it will be of interest to know that had we used the same amount of coal in 1929 as we did in 1921 to move 1,000 tons of freight 1 mile, we would have consumed 1,158,710 tons of coal more in 1929 than were actually used.

What we have done in the matter of finding better ways to use coal has likewise been done by practically all railroads of the United States, so that had they consumed in 1929 the same number of pounds of coal to move 1,000 tons of freight 1 mile that were used in 1921, they would have consumed an additional 40,000,000 tons, equal to 70 percent of the entire 1929 output of bituminous coal from the State of Illinois. Other industries also were able to perfect their combustion methods, particularly the electrical utilities where a kilowatt-hour of electric current consuming 3.2 pounds of coal in 1919 required only 1.69 pounds of coal in 1929, an increase in efficiency in so far as coal is concerned of 47.2 percent, equivalent to an annual saving of 40,100,000 tons. In other words, the railroads and electrical utilities are saving more than 80,000,000 tons of coal annually, equal to the 1929 production of bituminous coal in the States of Illinois and Indiana.

While I do not care here to deal with the factors that entered into the production cost of coal, I do know that the cost became so great during the war and immediately following that the engineering genius and skill of the country sought—as it always seeks to do under such conditions, regardless of whether it is coal or some other commodity—either to replace that product or provide for its more efficient use. Meanwhile, the coal operators were alive to the situation, and while they were likewise confronted with serious problems growing out of the war, there seemed to be some inexorable laws from which there appeared to be no escape.

In the operation of our mine we were confronted with many of the same problems, and inasmuch as we had approximately $5,300,000 invested in coal lands and physical plant, with the ever-recurring fixed charges, including taxes, etc., we faced a difficult task. Had we closed our mine it would have thrown a large number of men out of work, in addition to making it necessary for the railroad to absorb the carrying or fixed charges of the mine property in its operating expenses. Accordingly in 1926 we adopted this policy:

> No work will be done manually that can be accomplished through mechanical means, provided the economics are sound (giving due regard to the human factor).

Concurrently with this declaration of policy we delegated a man who had both technical and practical experience to visit not only the large and small mining properties of the country but aggressive manufacturing plants as well, with the sole purpose of finding better and more economical ways of doing the job of mining.

After some considerable study, the first thing that we did was to mechanize our top operation. This was done through the introduction of:

1. Tractors equipped with special appliances, such as booms and hoists.
2. Clamshell crane and magnet, mounted on heavy-duty automobile truck so that quick moves might be made from one point to another.
3. Installation of overhead monorails in our shop and storeroom so that heavy parts taken into and brought out of the mine might be handled to the points where wanted with a minimum of manual labor.
4. Small gasoline track locomotive.
5. Gravity conveyors, so that supplies such as cement, concrete blocks, etc., might be unloaded and conveyed, if necessary, from 200 to 300 ft., thus avoiding unnecessary handling by the workmen and the elimination of demurrage charge accruing on railroad equipment.
6. Installation of electric heater with thermostatic control, so that when only a few men are worked on an idle day the cost of providing them with hot water for bathing might be reduced to a minimum.
7. Various other devices and machinery.

The results obtained were satisfactory.

Meantime we were looking forward to a broader program of mechanization, and our studies in this direction were intensified because we wanted to give our miners work, equal at least to the average of the field. Likewise, there was a duty we owed to our commercial operators which we felt we were obliged to fulfill. We considered our policy humanitarian and broad in principle and spirit, but the problem that confronted us was difficult, although one that had to be met. Wherever machines were in use which offered an opportunity for study in the interest of economy, our engineer was sent to that particular mine or industry for the purpose of collecting such data as was necessary to permit us to reach a proper decision. Much valuable information was obtained, but we were confronted with a serious conflict of statement and opinion by those in charge of the various properties visited. After careful analysis we reached this conclusion:

> While there are certain inherent principles involved in the mining industry, notwithstanding the knowledge gained from practices in effect in our own, as well as districts outside the state, our problem was very largely separate and distinct in itself, and our job was to make the best methods and appliances applicable to our own operation.

And as the opportunity afforded this we proceeded to do, but we were careful to adopt no unit unless it gave us an adequate return in addition to earning sufficient to retire itself during its normal life.

Preparatory to this larger program of loading coal mechanically, we concluded that one of the most important matters was that of ventilation, because our coal is naturally gassy, and inasmuch as mechanical loaders create more coal dust than does hand loading, two serious problems immediately presented themselves. The matter of (1) ventilation we proceeded to correct by thoroughly cleaning and center propping our airways. As the work progressed there was a substantial increase in the volume of air delivered to the face, with a considerable reduction in

(*Continued on page* 74)

* President, Valier Coal Company.

Four Years of MECHANICAL LOADING in Southern West Virginia

By Herbert B. Husband *

MECHANICAL loading in the mining properties of the Chesapeake and Ohio Railway Company was started in 1926 as a matter of necessity.

The properties were acquired during the World War when sufficient fuel necessary to operate heavy trains over long hauls was difficult and at times almost impossible to obtain. The properties were pushed to the limit and, because production was the most important item, all energies were directed to this end. In a few years the available territory was used up, and in 1923 Sarita No. 2 mine was opened to offset the declining tonnages in the old mines.

The coal is what is known locally as the Dorothy seam and ranges from 8 to 12 ft. thick and carries three slate partings. The first parting is 18 to 24 in. thick and occurs from 2½ to 3½ ft. from the bottom; the middle band is 8 to 12 in. thick and occurs at approximately the middle of the bed; the third slate band is about 18 in. down from the roof and ranges from 4 to 6 in. thick. The last 18 in. or the top coal is left up for roof, as the bed carries 10 to 15 ft. of slate overburden which can not be held after the top coal is taken.

Development was started by hand-loading methods, two men in each entry working double shift; that is, eight hand loaders to each pair of entries. After the first year it was seen clearly that we were not developing fast enough to offset the declining tonnage in the old mines, and steps had to be taken to increase the speed of entry development.

A study was then made of the different types of mechanical loaders then on the market. Actual inside examinations were made of the loaders under working conditions, and after comparing all the facts as they affected our operations we decided on a shovel-type track mounted loader. This type of loader was selected because it was a track-mounted machine, and as such would operate on the track laid for the cutting machine, also because of the record the machine had established for durability and because of its record of low maintenance cost. For our problem it was essential to have a machine that could be depended on to load day after day and night after night. We were not seeking maximum tonnages, neither did we expect to accomplish any great savings in cost, but we did expect to advance our entries 60 ft. per calendar day of two shifts, day and night—and we did.

All track work was carefully planned. It is not necessary to go into details concerning these plans, as what is best suited to our conditions perhaps would not suit even a neighboring mine; but we do believe that carefully planned track layouts are essential to successful mechanical loading operations.

Break-throughs are driven on 60-degree angles, and track is always left in the last three. This gives a parting close to the working face.

The loading crew was organized and instructed before the first loader was actually received, so that when it was received each man knew his duties and what was expected of him. The crew consists of mechanical-loader operator, helper, shoveler, cutting-machine operator, helper, shotfirer, motorman, and brakeman. The men employed on the mechanical loaders are paid higher day rates than any other class of labor. The crew is an operating unit in itself. The mechanical-loader operator is in charge of and is responsible for the discipline and the efficiency of his crew, and is permitted to select the men comprising it. The mechanical-loader helper, as his title implies, is a helper to the operator. The shoveler is a common laborer who picks slate and cleans up spillage from the machine. The cutting-machine operator and his helper, using an arcwall-type machine, cut and drill the coal. The shotfirer charges and shoots the holes, and the cutting-machine operator, his helper, and the shotfirer extend the track by using 6½-ft. sections of steel rail. These sections are made of 30-pound rail and steel ties. It might be well to note here that several types of patented track were tried, but all proved to be failures, and the use of ordinary 30-pound steel rail on 6-ft. sections was found best.

The first loader was received in March, 1926, and put in service immediately. Difficulties, too numerous to mention, were encountered. All our carefully laid plans helped, but there were a good many details that had been overlooked and readjustments had to be made. The first day less than a cut of coal was loaded, although we worked hard all day; the second day two cuts were loaded, but after the first week the organization began to function and things picked up. After the first month the cost of operation was kept in the same manner as for any other section, and every item properly chargeable to mechanical loader operation was taken into account. It was found after the first year of operation that coal was being loaded 9 cents per ton cheaper mechanically, and entries were being advanced six times as fast as they had been by hand loaders.

The moderate success obtained with the first loader lead to the purchase of a second one in December of the same year. The second loader was put in operation with the same type organization and under the same plan of operation in our Dorothy No. 2 mine, which was then being opened in the No. 5 Block seam. This bed is 7 to 9 ft. thick and has one slate parting of 8 to 10 in. nearly in the middle of the bed, and carries 8 to 32 in. of draw-slate, which comes when the coal is shot. Entries were advanced faster in this mine, despite the heavy draw-slate, than they were in the Sarita No. 2 mine, and the savings in cost were even greater.

In August of the following year the number 1 loader was transferred to the Dorothy No. 2 mine, making this a mechanical mine. The operation, viewed from any angle, was a success.

In January, 1929, the Eunice No. 2 mine was opened in the No. 5 Block seam. Conditions in this mine are nearly ideal for mechanical loading, as the bed carries a sand-rock roof and has but two bands of impurities, one of which, a soft gray slate, is cut out by the cutting machine. On account of the sand-rock roof and the limited impurities, it was here that our maximum efficiency in mechanical loading was obtained. We are now operating three mechanical loaders in this mine day and night, with six crews.

Coal has been loaded mechanically for the last four years. Each year has shown an improvement over the year before, and more coal and cheaper coal has been loaded. A little less than 9 miles of entry has been driven mechanically and nearly 300,000 tons of coal has been loaded. This experience is sufficient to prove that mechanical loading under the various conditions represented at these properties, is safe, practical, and economical.

No effort has been made to produce lump coal, but from the amount of lump coal loaded we know that were it desired to load a high proportion of lump, this could be accomplished, although it would lower the loading efficiency somewhat, as the coal could not be shot as hard as it is shot now. The loaders have met the tests for clean coal even when loading in Sarita No. 2 mine, where there are three bands of slate; the best proof that these loaders have met the tests for clean coal is the fact that this coal was accepted as fuel for some of the best trains operated by the Chesapeake and Ohio Railway Company.

We realize perhaps better than anyone else how much lost time there is and that we are not operating as efficiently as we should. Time studies show considerable losses; gradually these losses are being eliminated, but even as inefficient as we know we are, the cost savings are tremendous and the far-reaching effect of the thousands of feet of entry driven in short periods, allowing concentrated working areas, has had on our mines as a whole can not well be estimated in concrete figures.

* General Manager of Fuel Mine Operations, Chesapeake & Ohio Railway Company.

OPERATION with CONVEYORS

By F. W. Whiteside *

THE problem of moving coal from the mine working face to the pit car and thence to the tipple is one to which the company I have the honor to represent, has devoted a considerable amount of time, money and experiment. While I think I can truly state that we have made a certain amount of progress, there are, no doubt, many features of the problem which are still unsolved.

It is an accepted fact that any mechanical loading or conveying device, to be at all efficient, must be so designed and so serviced that it will be operating the maximum number of hours per shift. It matters not how well designed or how efficient a machine may be, if it stands idle for 50 percent of the time, while waiting for material to handle or for cars into which to load, it cannot be more than 50 percent efficient.

In the middle west some form or other of the room and pillar system is most generally used.

The coal measures lie in the Mesa Verde and Laramie deposits of the Cretaceons Period, many millions of years younger than the Carboniferous coals of the Mississippi Valley and the eastern fields. The coal beds are separated by strata of sandstones and soft shales of which most of the latter disintegrate rapidly upon exposure to the mine air. Hence a coal mine with a sound roof is a rare discovery. Practically all working places in many mines require timbering to within 3 or 4 ft. of the face. This makes the use of loading machines difficult and expensive if not prohibitory. Mechanical operation is therefore reduced to the use of conveyors.

The thickness of the coal seams mined in Colorado varies from 2½ to 100 ft. The majority, however, measure from 4 to 9 ft.

Having in mind the great amount of time lost while waiting for pit cars, with any type of conveying or loading machine, our first thought was to develop a conveyor with which five or six cars could be loaded in a 20-ft. room without uncoupling them, the entire car trip to be standing in the room and not on the adjacent entry.

Our first conveyor consisted of a bullnose of rugged construction which is thrust into the loose coal at the face of the working place. From the tip or forward end of the "bullnose" the coal is carried on a 30-in. steel apron conveyor up an incline 15 ft. long to a vertical height of 6 ft. 3 in. above the top of the rail of the mine track. At this point the bullnose frame is attached to the main conveyor frame by a hinged joint and from here the conveyor apron travels in a plane parallel with the mine track to the point of discharge, 42 ft. distant.

The main conveyor frame consists of two steel articulated trusses 5 ft. 10½ in. in height and 42 ft. long, placed one on each side of the mine track and parallel to it 5 ft. 8 in. center to center or at such a distance as to permit the free passing of mine cars between. The trusses are held in proper position by steel cross members and corner braces, the former of which carry the travelling apron which is also parallel to and approximately 6 ft. above the center line of the track.

Where the two trusses rest upon the mine floor they are provided with steel shoes upon which the main conveyor slides forward or backward as desired.

The electric drive motor is mounted at the discharge end. It is 5 hp. and has a speed of 900 r. p. m.

The apron conveyor travels 60 ft. per minute and has a capacity of 60 tons per hour. The machine is provided with a nigger head to slide it toward or away from the working face. There are, of course, the necessary clutches for throwing the conveyor apron, the car mover drum and nigger head in and out of gear. The mode of operation is obvious. By means of the nigger head the machine is pushed forward toward the face and the lower or forward end of the bullnose driven as far as possible into the loose coal.

A trip of five or six coupled cars is then switched into place so that five of them stand between the supporting trusses and under the conveyor apron, the sixth being in position to receive the coal from the discharge end. When car number six is loaded, a rope, operated by the conveyor motor, pulls the entire trip outward or away from the face until car number five is in position to load. After it is serviced, number four is spotted and so on until the entire trip is loaded, when it is pulled to the parting by a rope operated by the conveyor motor or perhaps by one of the mine locomotives.

The method of placing coal upon the bullnose to be most efficient requires that as little shovelling as possible be done. It is singular that our greatest difficulty with this machine has been to get the loaders to keep it up to the loading face. Rather than move it 5 ft. forward with the nigger head they will often be found throwing the coal to the conveyor this distance, with their shovels.

This machine has worked very successfully in room or entry driving. Due to its overall length of nearly 70 ft. it cannot be moved from one working place to another without dismembering. Hence, when once set up in a room or an entry, there it remains until the place is finished.

The cost of this conveyor was $2,375. It was designed in our office and constructed in Denver in 1926 and is still operating successfully.

Our next experiment in conveyor design was based upon the same fundamental idea as that embodied in our first machine; namely, to load five or six coupled pit cars in a room or entry without uncoupling but in thin seams of coal.

This machine employs a 15-ft. bullnose quite similar in design to our first machine. It differs in this respect in that the loading end may move in the arc of a circle about an axis near its point of discharge thus enabling it to be moved to either corner of a 20-ft. room for convenient loading.

The bullnose apron discharges the coal onto a stationary steel conveyor sheet 2 ft. wide by 45 ft. long, over which it is dragged by angle L-shaped flights attached to a single strand straight link coil chain which travels along the left edge of the conveyor pan and turns at the ends about head and foot sprockets mounted upon the vertical shafts. The height above the mine floor of the discharge end of the bullnose is 18 in. and of the discharge end of the main conveyor 41 to 60 in., depending upon local conditions.

It is driven by a 7½ hp. electric motor mounted near the discharge end of the main conveyor and is provided with rope drums for moving it toward or away from the face and for switching the car trip.

The coal is discharged to the side of the conveyor and as the empty L-shaped flights return they drop into a vertical position thus occupying a minimum of space and permitting the car trip to stand close to the conveyor. As in the case of our first experiment the machine is mounted upon two runners or shoes running the full length of the main conveyor on which it slides toward or from the face.

This machine we have named the Snodgrass conveyor in honor of B. W. Snodgrass, the president of our company. It was he who furnished the original idea and followed the development and construction of the device to its present state of efficiency.

In operation it is placed parallel to the mine track with its center line approximately 5 ft. from the center line of the track. The forward or bullnose end is pushed into the loose coal at the face and a trip of six coupled cars are spotted alongside the machine with car number six opposite the discharge point. After number six is loaded number five is spotted at the discharge point, and so on.

The speed of the conveying flights is approximately 60 ft. per minute and the capacity of the machine 50 tons per hour.

Like its predecessor, this machine is best adapted for entry driving or for loading coal in rooms of considerable length.

We have constructed 12 of these conveyors, all practically of the same design. Should we decide to build more of this type it is probable that an attempt will be made to lighten it if this can be accomplished without a sacrifice of strength. The cost of each machine was approximately $2,200.

About the time our second experiment in conveyors was approaching a consummation one of our superintendents, G. D. Jones, produced a small model of shaking conveyor which gave promise of accomplishing good results. This machine is of the differential stroke plan shaking type. It differs from others of this class in the manner of fastening the pans together, in the design of the drive unit, in the manner of communicating the differential shaking motion to the side or tributary conveyors and in certain other particulars.

The mechanical principal of the drive unit is far from being a new one. Briefly,

* Chief Engineer, Victor-American Fuel Co.

the slow and fast stroke is produced by a pitman, one end of which is mounted on a sturdy shaft. Forward of this shaft and so located that its center line passes through the center of the shaft is a slot or guide in which a crank pin travels, the latter being mounted upon a heavy revolving disc. The dirve connections to the conveyor and tail ropes are located at equal distances above and below the pitman shaft and in a line at right angles to the slot or guide in which the revolving crank pin travels.

While we have never changed the principal of the drive, the various members have undergone more changes and more development than is experienced by a child growing from infancy to manhood.

Basing our plans upon our experiences with previous conveyors, our first electric drive motor was one of 5 hp. As the lengths of conveyor pans continued to grow from day to day, larger and larger motors were substituted for the original until today we are using a 50-hp. machine and the total length of conveyor pans actuated by a single power unit has increased from 400 to 2,300 ft.

With the increase in motor strength there was necessarily a demand for heavier shafting, gears, pillow blocks, base frames, etc. These, with the exception of the pillow blocks, are all of steel.

We have experimented with base frames of structural shapes and of cast steel. The last two constructed were of the latter and so far have given a remarkable account of themselves.

Attached to the pitman with heavy clevises are the pan and tail ropes, one of each. The former drives the pans on which the coal travels. The latter pulls them in the opposite direction. In other words, the main rope after leaving the drive unit, passes to the conveyor pans thence under them for their entire length, thence to and around a bull wheel or in some cases the ends of the two ropes are attached to an even lever, and thence back to the tail rope connection on the pitman. The main and tail ropes are not each in one piece but are or may be composed of a number of shorter sections of rope, their ends fastened together.

The main rope constantly travels under the center line of the conveyor pans and is fastened to them, one fastening to each pan, by powerful rope grips or clamps of our own design.

The pans themselves overlap slightly where they join, but are not bolted, riveted, or otherwise fastened together. Their lap and spacing, one with another, as well as their shaking strokes, are maintained by their connection to the main drive rope.

As first constructed the conveyor trough was carried on 4-in. diameter wheels which rolled on the mine floor. Later it was hung on chains from the mine timbers above, a pair of chains to each pan. This method proved much more satisfactory as the action of the conveyor was improved and much less power required to operate it.

Our first crank pins were capable of a number of different settings on the crank to increase or decrease the diameter of the circle which they describe. Likewise the two points of attachment on the pitman to which the main and tail ropes are fastened could be shifted toward or away from the center of the pitman shaft.

However, numerous trials convinced us that a 7⅝ in. radius for the circle of travel of the crank pin and a distance of 7 in. each way from the center of the pitman shaft to the centers of the two drive rope connections gave the best results. Likewise, the speed of the crank shaft was varied from 40 to 90 r. p. m. in numerous trials when it was found that approximately 70 r. p. m. was most satisfactory.

The foregoing is a brief description of the main conveyor which is designed to discharge its coal into the cars of a trip standing on a parting holding two full rope or motor trips.

To provide transportation of the coal from side entries and their tributary rooms lateral conveyors, each discharging upon the main conveyor, are employed, each driven from the two ropes of the main conveyor by a device which we have been pleased to call a cross-bell crank.

The side entry and room conveyors are similar in design to the main conveyor with the exception of the drive, the differential motion of the pans being derived from the ropes of the main conveyor instead of by means of a separate drive unit.

Like the drive head, our cross-bell cranks have passed through a number of stages of development. Perhaps the best results have been obtained by the employment of two sheaves mounted upon the same vertical shaft, one driven by the ropes of the main conveyor, the other driven from the first sheave through a clutch. To the second sheave are attached the drive ropes of the lateral conveyor.

The coal loaded at the faces of the rooms is carried by a room conveyor, similar in design to the main line unit and driven through a cross-bell crank by the lateral conveyor ropes.

Such, in brief, is the description of our Jones conveyor. There have been many changes made in various parts of the machine, all of which have, we think, corrected previous errors of construction and design.

At our Delagua Mine in Las Animas County, Colorado, our main line conveyor is nearly 900 ft. long and operates on an average grade of 4 percent in favor of the travel of the coal.

It has two laterals, one 500 ft. in length from which are turned five room conveyors. The coal from these rooms travels downward at an average grade of 4 percent into the main lateral which moves it against an adverse grade of 2 percent to the main conveyor.

The second lateral, at this writing, is approximately 450 ft. long and carries the coal from four rooms down a 2 percent grade to the main conveyor. The total length of all conveyor pans in rooms, laterals and main line is over 2,300 ft. all operated from one drive unit.

At our Pinnacle and Wadge Mines in Routt County, Colorado, our Jones conveyors have given a good account of themselves.

In the former property the grade of the main conveyors varies from 25 to 33 percent and that of the tributaries from 3 to 4 percent, all grades being in favor of the direction of travel of the coal.

In the Wadge Mine the main pans operate on an average gradient of 17 percent and the laterals about 4 percent, all in favor of the travel of the coal.

The conveyors have been of particular service in the Pinnacle and Wadge Mines, on the steep grades, as a large amount of money is saved annually by the avoidance of dragging empty pit cars up these pitches, to say nothing of the wear on hoist brake shoes, ropes and other accessories.

In the foregoing descriptions of our three types of conveyors no attempt nas been made to go into the engineering details of the machines described, nor has any attempt been made to enumerate or describe the many small changes which have been made to strengthen weak places and improve the general designs.

Naturally the question arises: can any money be made by the use of these machines? Up to the present time so much of our work has been in the experimental stage that accurate data as to cost of operation and possible amounts of money to be saved must of necessity be very inaccurate. However, from the results so far obtained we believe that by the use of these conveyors we will effect a saving of from 25 to 50 cents per ton.

DISCUSSION

Operation With Conveyors

George A. Brown, *mine superintendent, Union Pacific Coal Company, Superior, Wyo.:*

In discussing Mr. Whiteside's paper, which is interesting because of the experiments in conveyor mining, we have spent practically four years in conveyor mining. I might state we have had to practically rebuild every machine that we bought before we could work them.

The different companies that are making conveyors at the present time have made quite a number of improvements in equipment since that time. I believe it is possible, to this time, to get conveyor equipment that will stand up and do its work.

The different types of conveyors on the market at the present time are more or less adapted to the different conditions which are met with in the different mines. They are all more or less efficient under different conditions of work. However, when we talk of efficiency I do not know of a single conveyor, or loading machine of any type that can be considered as 100 percent efficient. What I mean by that is from a production standpoint. There are some periods during which the machines are idle due to preparation of coal and natural conditions in the mine.

As far as natural conditions are concerned, I believe the Rocky Mountain region has some of the worst mining conditions to be met with in any place, and of course, we have some good ones too. In the mines that I happen to have charge of for the Union Pacific Coal Company it might interest you to know that we have a timber cost in one mine alone that runs up to 25 cents a ton. We are mining coal under those conditions with conveyors at the present time and we are doing it with what we consider success.

I have seen no operation where conveyor of some type or other could not be used.

(*Continued on page* 76)

Mechanical Loading In Anthracite Mining

for Rock Work and Reopening Silted and Caved Areas

By Sheldon Jones *

PROBABLY the least advancement in mechanical loading in anthracite mines is that of loading rock and refuse. Mechanical loaders were first put in operation to eliminate the blasting and handling of rock in breast and pillar mining.

The larger percentage of anthracite unmined is in thin veins. In developing these veins more or less rock must be taken, depending upon the size of the transportation equipment used. The loading of rock in that development is, to a large extent, hand work.

A large amount of pillar coal remaining is in veins that were silted with breaker refuse and boiler room ashes, the original gangways being filled. To recover the pillars, gangways must be reopened or new roads driven through the pillars and across silt filled breasts. That loading is almost entirely hand work.

Hand work in either case is slow and costly. Maximum production from thin veins requires speed in gangway development.

The advancement of mechanical loading in tunnel work has made more progress than other lines of rock and refuse loading. A number of very large tunnel jobs in the anthracite field are now 100 percent mechanical loaded.

However, the larger percentage of rock loading is hand work. This is due principally to the labor resistance. A large variety of very good loading machines are available, of varied types and prices, that can be fitted to almost any existing condition, which will speed up development or increase yardage, and correspondingly decrease the cost, provided the labor objections and interference can be overcome.

The Lehigh Valley Coal Corporation Exeter Colliery is principally a pillar robbing mine. Large areas in first mined veins have been filled with breaker refuse, boiler room ashes, and some veins are badly caved, the caves occurring before or during the process of silting. In pillar recovery it is necessary to either reopen the old haulage gangways or drive new roads through the pillars, across silt filled and caved breasts or other openings.

That reopening work has been to a large extent on an hourly basis of payment for labor, otherwise known as "company work," and until recently entirely hand loaded.

A Myers-Whaley loading shovel was installed in one of the smaller veins at that operation. Due to vein conditions and labor interference, that installation failed to produce the desired results. Recently the shovel was placed in the Red Ash vein, the largest vein at the colliery. The reopening of a large area, previously silted with breaker refuse and ashes, was started by the shovel. The vein thickness in that section averages 12 ft. A new road was driven through the pillars and across old silt filled and partly filled breasts, for a distance of 150 yds., the loading being done entirely by the shovel. The roof conditions were good, requiring very little timbering. The time required was 35 eight-hour days, total labor cost of $650, average advance of 4.4 yds. per day at $4.33 per yd.

Comparing this with hand loading under similar conditions; reopening 150 yds. of gangway—time required 115 eight-hour days, total labor cost of $1,375, average advance of 1 1/3 yds. per day, at a cost of $9.10 per yd.

Under conditions as cited, machine loading will advance at least three times the speed of hand loading. Where possible, it is advisable to have two gangways for a machine. Timbering and track work can then be taken care of without interference with loading. The shovel should be of such type that can be moved from one working face to the other without delay.

Pillar mining will not allow a large number of places retreating to the gangway at the same time. Therefore a greater number of gangways are necessary in pillar removal than in solid mining for the same production. Machine loading under the conditions described can be developed to a very high standard of efficiency and will very materially reduce the cost of reopening.

In veins and sections where bad roof or top prevails, the speed of reopening is then controlled by the timbering and roof support. In such cases machine loading will probably result in an increased cost.

At the Lehigh Valley Coal Corporation Hazleton shaft mine, at Hazleton, Pa., a mine-car conveyor loader was recently put in service for loading in a rock gangway to replace hand loading. That gangway is being driven for a drainage road, and maximum speed in driving is desired.

Hand loading advanced one 6-ft. cut in 24 hours. With the conveyor loading it is expected that two 6-ft. cuts will be taken out, and an effort is to be made to get three 6-ft. cuts in 24 hours.

The advantage of the conveyor loader over hand loading is principally due to being able to handle large pieces of rock, as made in blasting, up to one-half ton. The rock is rolled or barred on the loading boot of the machine and carried in to the car on the conveyor flights, which are saw-toothed on top for that purpose. This eliminates to a very large extent the time and labor required in breaking up the material after blasting, which is necessary in hand loading.

The mine car equipment at that operation is of large size, approximately 105-cu. ft. capacity, the top of the car 4 ft. 7 in. over the top of the rail. Hand loading is slowed up due to that condition. The conveyor loader places the loading point at about the track level for all material.

At the Chauncey mine of the Geo. F. Lee Coal Company, Avondale, Pa., conveyor loaders are being used for gangway loading. The vein worked at that mine is from 26 in. to 30 in. in thickness, approximately 6 ft. required for height over the rail. From 4 to 6 ft. of bottom rock is lifted on the gangway roads. One conveyor loading machine is used to load in two gangway fences. The labor force for two working faces consists of one miner, one laborer, and three muckers; the miner and laborer drilling and firing, the three muckers with the conveyor loading machine doing the loading. Three conveyor loading machine units, as described, are in charge of a foreman.

The method of payment for labor is an hourly basis. The same method of payment and rates were used for hand loading prior to the installation of the loading machine.

The improvement resulting by the use of the loading machine is 33 percent reduction in gangway yardage cost, an increase in yardage driven of 50 percent, compared with hand-loading results.

As stated before, the principal reason for the improved results produced with the loading machine is the elimination of time and labor required in breaking the large rock, which is necessary in hand loading.

A loading machine was recently put in operation in the anthracite field, manufactured by the Sullivan Machinery Company, known as a "Slusher" or "Mucker" hoist, for tunnel rock loading. This machine consists of a double drum hoist, air or electrically driven, mounted on a truck over a loading chute. The truck is built to track gauge. The chute on the front or face end of the truck is built to clear the rail, ascends on an angle to a level of the top of the mine car, and extends over the rear of the truck about the length of the car. The rear extension or overhang of the chute has an open bottom for discharging material in to the mine car.

The operating principle is main and tail rope attached to a "hoe" shaped scraper, which is pulled into the muck pile automatically loading on main rope pull. The loaded scraper is pulled from the face to the loading machine, mounts the chute and discharges the material into the car through the open bottom chute at the rear of the machine.

The main rope sheave is mounted on the end of the loading chute, the tail rope sheave to wedge "I" bolt in the face of the tunnel. Usually three "I" bolt holes are used, one near each rib, and the third in the center of the face of the tunnel. The "I" bolt holes are drilled at about the level with the top of the muck pile.

The machine is placed from 20 to 50 ft. from the face, one man operating the

* Lehigh Valley Coal Company.

hoist. No men are used between the machine and face while the scraper is in operation. The tail rope sheave is moved by the machine operator or transportation men.

The scraper is so shaped that it will ride over rough bottom or roadbed without interference. A small percentage of hand cleaning is necessary along the ribs, where the scraper does not reach. In an 8 ft. x 12 ft. tunnel a 6-ft. cut can be loaded out in from two to four hours.

This type machine eliminates the necessity of putting in short or temporary rails at the face. The machine can be placed for loading so that the track extensions can be made permanent and of full length rails. It is, however, advisable to keep the machine at the minimum distance from the face, as the traveling distance of the scraper increases or decreases the speed of loading.

Myers-Whaley shovels are being used in tunnel work and have increased the driving speed from 50 to 100 percent over hand loading.

In the development of the larger anthracite veins a larger percentage of rock and vein refuse was not loaded, the size of the veins allowing the material to be gobbed or stored at the location the mining was done. In the thin vein mining little or no gobbing can be done at the mining face; this condition requiring loading out all material mined. With the installation of mechanized loading in these thin veins, the development can be speeded up and cost very materially reduced.

In the western and southern anthracite field the mine car equipment in use, as a rule, is of large capacity and high mechanical loading is an advantage in gangway development both as to cost and speed of driving.

Long Wall and Long Face Mining Methods—Oklahoma (*Continued from page* 65)

to the coal as possible. The machine men help the timbermen if they get too far in advance of the timbers. The coal is shot down on the night shifts.

A small platform is built high enough to clear a car and long enough to intersect the bottom on about 10 percent grade. This platform is 4 ft. wide and 10 ft. long. It is easily moved to the new position.

At the beginning of the day shift two men start at the lower end of the wall with pick and bar. In most cases the bar is of most advantage as there are frequent cracks that can be used as a starting place to break the coal loose. At times a wedge has to be used to break the larger lumps. When 8 ft. of the wall has been taken down the two men lay a flat sheet below the end of the wall. This sheet is 4 by 8 ft., 14-guage galvanized iron. It is held in place by 6 or 8 20-penny nails driven into the bottom coal, that is left by the machine. This process is continued until the top of the wall is reached. Then the "sweeping down" or preparing for the machine starts. This operation consists of beginning at the top of the wall, taking up the sheets and placing them to one side, to be used again, and taking up the 3 to 4 ins. of bottom coal and shoveling it into the chute formed by the sheets. As the sheets are taken up, all coal that has fallen to the side is placed in the chute and loaded out. All of the coal slides to the car by gravity, when it is loosened on the wall.

Two timbermen follow the miners up the wall, setting a row of timbers between the row set by the night crew and the row outby them which is the row set by the night crew of the previous night. This leaves timbers on 3-ft. centers on the strike of the seam and 4-ft. centers on the dip. These are triangular-shaped split props, with a minimum side of 6 ins. These timbers will hold the roof until the wall has been advanced from 65 to 125 ft. A number of walls have been lost between these limits. They were recovered, if the wall had been cut, by taking out this cut or by driving a new wall up 10 ft. inby the one that had just caved in. This is a costly process and often had to be done when the demand for coal was greatest. It was found that by setting a double row of heavier props, 8 ins. round, at 50-ft. intervals, that this cave could be delayed while the face advanced 250 ft. The plan at the present time is to place cribs every 60 or 72 ft., then to drill holes 8 ft. into the top outby these cribs and to break the top at distances under which it is practical to work.

It has been found that the coal on the level below one that has been mined out is crushed on the upper end of the wall. This crushed coal is found for a distance of 25 or 30 ft. from the rib of the entry above. The chain pillars on the upper side of the same entry show very little effect of the weight. This operation is being carried on under approximately 800 ft. of cover.

Ten men complete the cycle of operation over a period of about 12 hours. The machine men and timbermen, working as a night shift, usually finish their work in four hours. One hundred and fifty tons are produced in each cycle.

The management considers the long face as an experiment with several details to be completed. Perhaps, the greatest problem to be solved is a method of breaking the top at some definite place. The disadvantage of handling heavy timber or jacks on a steep pitch makes roof control very expensive. If this control can be obtained the operation of a long face on a steep pitch will be as practical as in the more level seams.

Developments and Operations With Mechanical Loading (*Continued from page* 69)

the amount of power consumed in carrying it there; and (2) the element of hazard growing out of the increase in the amount of coal dust suspended in the return air, and which was destroying the effectiveness of our rock dust with the attendant additional cost of redusting, made it necessary to apply a corrective. This was accomplished by the introduction of 2-in. main and ¾-in. branch pipe lines, which permitted spraying the "bug" dust or machine cuttings. The results obtained were satisfactory, and in correcting the coal-dust hazard we were able to maintain the effectiveness of our rock dust, and at the same time provide better working conditions for our men.

The cleaning of roadways mechanically was another problem to which we addressed ourselves, because here there were three elements of danger involved, namely: (1) The pulverization of coal through the constant churning of pit-car wheels, (2) derailments, and (3) injuries to workmen by stumbling and falling, all of which cost us a considerable sum of money. After more than a year's study we discovered a way to accomplish this task with satisfactory results.

All the while we were conducting tests with various types of mechanical loaders to determine the one best suited for our conditions, because we realized the outlay of money would be considerable, and if we failed to select the proper unit for our needs it would simply add to our already large capital investment and present a more difficult task in producing the results we had to obtain to make this capital outlay attractive, and at the same time furnish employment for our workmen.

With these tests completed and our selection made we standardized on mechanical loading equipment, electric drills, and installed an automatic 500-kw. generator set and portable transformer stations, so that we would be certain of having an uninterrupted and adequate supply of power at the face where needed.

With the solution of the problems that confronted us we proceeded to drive our main, cross, and panel entries with the carbon-dioxide method of shooting, in addition to working three-men gangs in panels; and to show to what extent our development advanced, the following may be of interest:

Month	Lin. ft. of entries driven	Avg. lin. ft. operat'g day
December	6,347	302.2
January	9,061	348.5
February	7,341	333.7
March	4,034	313.1

In our judgment, carbon dioxide represents a forward step in the mining industry because it gives a rapid advance development so essential in mechanized operation. However, it should be entrusted only to highly competent men who, in addition to safeguarding the operation from flying shells, should likewise test for gas before shooting, so as to preclude the possibility of a "bleeder" suddenly filling the head of the entry with gas without the knowledge of those doing the shooting, the latter, as you probably know, being accomplished by an electrical impulse actuated by a magneto.

Finally our mechanization program has been fully completed. We did the things we set out to do. The results have been highly satisfactory, enabling us to give our miners employment instead of closing the mine and summarily dismissing them. At the same time we have afforded our commercial operators substantial relief.

PREPARATION

. . . . . at mines of White Oak Coal Company

By W. E. Tissue *

THE increased activity of the oil, gas, and coke merchants in the domestic fuel market today make it necessary for each and every bituminous coal producer who is competing in this market to keep closely in touch with any and all developments in preparation, and other factors, that will enable him not only retain his present business but also place him in position to enlarge it.

The coal-buying public today is no longer satisfied with the preparation of yesterday because coal is being offered today from more modern plants, each specializing in some feature of sizing, cleaning, or other form preparation. These modern plants are the answer of the smokeless operator to the ever-increasing demand for a better prepared fuel.

Appearance is being recognized as a determining factor in the sale of coal as fuel. Bright, shiny, clean, well-sized coal appeals to the buyer, and gives general satisfaction when used. Coal containing bone, or stained by mine water can be readily detected by the buyer because of its appearance, and is frequently rejected and must be removed at considerable expense.

The old-time method of having a tipple employe designated as an inspector and detailed to look after the preparation of the coal, as a side issue in addition to his other duties, is a thing of the past. The requirements of the coal buyer today are such that an efficient and successful inspection department must be organized and function as a separate unit, distinct from the operating department. It, of course, must work in harmony with the operating department, but it needs keep more in contact with sales problems and be able to aid the operating department in meeting the needs of the market.

Supervision by the inspection department must begin at the face even before the coal is undercut or shot. Both cutting and shooting methods determine the percentage of coarse coal obtained in each machine cut. The type of explosive; the position of the holes; the nature of the impurities and their place in the bed; the amount of explosive used, must be taken into consideration and be looked after by the inspection department if the best of results are to be obtained.

After the coal has been shot down, the impurities, if any, are then removed as the coal is being loaded. Where impurities are known to exist in a working place an examination of the gob by an inspector will soon indicate whether the miner is loading out his impurities or throwing them back in the gob where they belong.

We merely cite you this method of inspection in use at the White Oak Mines preliminary to describing the preparation in use at our Oakwood plant.

The Oakwood Mine of The New River Company, one of the mines producing White Oak smokeless coal, is in The New River District at Carlisle, Fayette County, W. Va., 6 miles north of MacDonald, and is served by both the Chesapeake & Ohio and Virginian Railroads.

The coal worked at this mine is the famous Sewell bed of the smokeless group of West Virginia coals, which lies approximately 500 ft. below the surface at this point. It averages 49 in. in thickness and is exceptionally clean. However, in the process of mining, certain small impurities, mostly slate particles, get into the coal and it was decided to test a washer to remove these small impurities from the nut and stove sizes. The few impurities in the lump and egg sizes are removed by hand by the coal inspectors stationed at the end of each boom. The screenings below one-half inch need no cleaning as the ash runs well below 5 percent and the sulphur does not exceed 0.5 percent.

The method of mining at this mine is room and pillar. The mine is equipped with steel mine-car equipment and electric locomotives operating on 60-lb. steel rail, to deliver coal to the shaft bottom.

The coal cars are hoisted up a two-compartment shaft on self-dumping cages by means of electric hoists. Rock cars are also hoisted by the same means. The rock is diverted to a 50-ton refuse bin in the tipple from which this material, together with picking table and washer refuse, is disposed of by means of an electrically operated larry car.

The Oakwood shaft has recently been enlarged at considerable expense, to permit the use of larger cages and mine cars. The mine has been equipped with new steel cars having an average capacity of 3 tons each. These new cars are double the capacity of the former ones, and this increased mine car capacity reduces the operating cost of the mine.

This all-steel and concrete preparation plant was designed and constructed by The Pittsburgh Coal Washer Company, of Pittsburgh, Pa. The tipple has a capacity of 400 tons an hour and the washer a capacity of 120 tons an hour, and is now working at its rated capacity. The scheme of operation of the plant is as follows:

The self-dumping cages discharge the coal from mine cars into a dump chute which is equipped with a fly cage for bypassing the mine rock to a a 50-ton refuse bin. The coal passes from dump chute to a 5-ton capacity electrically operated weigh basket equipped with automatic scales, where it is weighed and then discharged into a 7-ton receiving hopper.

The coal is fed from this receiving hopper by a reciprocating plate feeder to a set of tipple shaker screens which are 7½ ft. wide and built for making a separation of lump, egg, stove, and 1-in. screenings, over perforations designated as standards by Smokeless Coal Operators Association. The 1-in. screenings discharge onto a second set of tipple shakers of the flexible type immediately beneath the first set.

The tipple is arranged so that it may be operated independently of the washer if desired. The lump coal is sized over a screen plate 7½ ft. wide by 15 ft. long. The egg is sized over a screen plate 7½ ft. wide by 20 ft. long, and the stove over a screen plate of similar size. The nut coal is sized on a flexible shaker which is 8½ ft. wide and equipped with screen plate 20 ft. long.

We are informed these two sets of tipple shakers have the largest screening areas of any equipment in the smokeless coal fields. In addition to these large screening areas, the main tipple shaker is also provided with suitable lip screens to give the lump and egg coal a final dressing before passing to the booms. These booms are of standard apron type construction, each driven independently by a motor and speed reducer. Electric hoists, operated from coal inspector's platform, are used to raise and lower the booms.

The refuse picked from the booms is thrown into convenient chutes leading to a conveyor which takes the refuse material to a vertical elevator leading to the 50-ton refuse bin already mentioned.

This elevator is also arranged to be used as a clean-up elevator to recover the coal spilled under the tipple while loading railroad cars. This spillage is wheeled to the boot of the elevator, and a convenient fly gate in the discharge chute permits the coal to be received and hoisted to the tipple and passed over the screens, thereby recovering this coal which is ordinarily wasted.

When the washer is operating, all coal from 2½ in. to zero drops to the flexible shaker immediately beneath the main tipple shakers, where the ½-in. coal is separated and loaded direct into the railroad car, and the 2½ to ½ in. size (or stove and nut) pass on to the washer. The size of this flexible shaker screen is 8½ ft. wide and contains a screen plate 20 ft. in length.

When the tipple is operating on a dry basis, stove size is loaded with a boom on the stove track and the ½-in. screenings (pea and slack mixture) are loaded direct into railroad cars on slack track.

A mixing conveyor and a slack conveyor have been installed so that any desired mixtures of the different sizes may be made. A set of rolls has also been installed to break up the lump coal

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into egg size and resultant smaller sizes during times when it is difficult to market lump coal.

When operating these rolls, the lump coal is discharged from lump boom into upper strand of mixing conveyor, at the front end of the boom house. This conveyor carries the lump to the rolls immediately above inside of slack track.

After the lump has passed through these rolls, it passes to the upper strand of slack conveyor which conveys the coal back to the tipple shakers.

By means of an extension of the mixing conveyor, domestic coal of any desired size can be conveyed to a domestic bin on the highway passing the tipple.

The washer was designed and built to wash the nut and stove sizes. When the washer operates, the ½-in. screenings are either elevated to slack storage bin, as before mentioned, or loaded direct from the tipple flexible shakers into railroad car on slack track.

The ½ by 2½-in. (stove and nut) coal passes from the flexible shakers to the lower strand of a raw coal scraper conveyor leading to the washer where these sizes, mixed, are discharged into two Pittsburgh washing jigs operating in a concrete tank system at ground level.

The refuse from the jigs passes to the refuse tank from which it is raised by an elevator and discharged into top strand of raw coal conveyor. This conveyor takes the refuse back and elevates it to the 50-ton refuse bin.

The washed coal from the jigs passes to a concrete tank from which it is elevated and discharged onto a set of flexible shaker screens above the storage bins.

There are three of these 90-ton steel storage bins, one for slack, as previously mentioned, one for nut, and one for stove. The stove and nut sizes are lowered into their respective bins by means of spiral chutes to reduce degradation to a minimum.

Clear water is sprayed on the coal as it passes over the washed coal shaker screens, and the fines washed off are sliced to a sludge tank, from which they are elevated by sludge elevator and discharged into slack bin.

Both the stove and nut bins are equipped with apron feeders for feeding the material out of the bins. These sizes first pass over large Pittsburgh vibratory screens installed between the feeders and the boom. These vibratory screens, of which there is one for each size, take out any fines due to degradation in the bins; help to free the coal from sludge and water, and the product loaded into the railroad car by a loading boom is, therefore, free from any fine material whatsoever.

It is to be noted that these two sizes of coal — namely, stove and nut — are triple screened; first screened over extra large screens, then washed and rescreened over flexible shakers; sprayed with clear water and finally again rescreened over fast moving vibratory screens, running at 1,000 r. p. m. before going into the loading boom for loading in railroad cars.

The washer takes out practically every piece of slate and bone with no loss of good coal to speak of, and owing to the firm structure of the coal and the manner in which it is handled, there is but little degradation. All degradation is readily apparent by observing the amount of sludge or fines in the sludge elevator buckets. When the washer is operating there is only a small amount of these fines being elevated to the slack bin, which proves conclusively there is but little degradation due to the washing process. The percentages of screened coal obtained since the washer was put in operation also prove this fact. The rejections of the washer run approximately 2 percent of the input.

The plant is of extra heavy steel and concrete construction and the machinery is rugged to withstand severe usage with minimum upkeep.

The structures are housed with zinc-coated iron, and ample skylights and all steel sash windows are provided to light all parts of the structure properly.

Motors are 440 volts, alternating current, 3-phase, 60 cycles, and are of the drip-proof type, operated with magnetic controllers by means of push buttons. The push buttons are at convenient points for tipple and washer operators.

The conveying and elevating units are driven by herringbone speed reducers, and the shaker screen units are driven by "Vim" leather belt transmissions.

This plant has been in operation for about three months and the product shipped from it has been entirely satisfactory. We have not as yet received one complaint from the customers to whom this coal has been shipped. Furthermore, as this is our first washer plant, we expect even better results, if that is possible, after our men become more familiar with the various adjustments that must be made from time to time, to equipment of this kind.

Operation With Conveyors (*Continued from page 72*)

They can be used more universally than any other type of mechanical loader. The main drawback for all types of mechanical loaders, as we see it, is the lack of ambition and sympathy in the change from the old mining methods, more especially with the management. They proceed more or less in a half hearted manner which eventually permeates through the whole organization.

I am talking from experience along this line. We have companies in our field that have gone to mechanical loading with practically the same equipment that we are using, and with which we are making a success. That equipment is in their mines for three or four months. Some of them throw it out and are not doing anything with it at all. That is so at the present time. There is no reason why, in my mind under the same conditions and in the same field where one company can operate machines and make them pay, another company cannot do the same thing.

There are certain periods when we get discouraged. It requires a lot of hard work and preservance to put this thing over. The human element enters into it too. That is one of the greatest factors. Everybody in connection with the operation is more or less skeptical when the method is changed. Therefore, it is necessary to have a coordination of effort from the top down.

We consider that our company is past the stage of experimental work. We do not mean by that that we are not learning more all the time. For the past two years our conveyor operations have become more or less standard practice. Our moving charges and maintenance costs are considerably less than when we first started. Our production per man is running fairly uniform.

In 1929 we mined with conveyors 420,000 tons in one of our operations, and drove 9,400 yards of narrow work under some of the worst mining conditions found anywhere. The average tonnage per man, under these conditions, runs from 12½ to 13 tons per man. When I say 12½ to 13 tons per man I mean every man who is employed on this operation, and that includes machine men, timber men, blasters, drillers, even the dummy boy who makes the dummy, the slate pickers and maintenance men. That is putting the coal on the pit-car.

We use the shaking type of conveyor with duckbills in all of our operations, working mostly room and pillar. We believe there is a great future for conveyor mining and that there is a great saving over hand mining and that is what we are all interested in.

Our company has kept very accurate costs and records of all matters pertainin to mechanical loading, which we believe is essential to secure an accurate comparison between the old methods and the new ones.

I am not going into the different types of conveyors on the market. They all have their good and their bad points. It is more or less a matter of opinion as to the merits each one has.

I have some figures here from one of the operations of the Union Pacific Company for a six month period which might be interesting to you. For this six month period on six conveyors in the Winton Mines, we have an average tonnage per man shift of 13.3, another mine we have there called No. 7 mine, six more shaking conveyors for a six-month period, with an average tonnage per man shift of 13¼ tons. Labor cost on the first operation I quoted were 58.6. The labor cost on the second operation quoted was 59.4. The moving cost of these machines runs about 2½ cents per ton. The cost of maintenance is around 2½ cents per ton, which is a straight labor cost.

We have shaking conveyors in practically every mine but two, out of 11 operating mines. We have all types of loading machines outside of that as working conditions permit. That was stated by previous speakers. Conditions are the things that govern your action in relation to merchanical loading.

The fluctuation in labor costs runs anywhere from 55 to 67 cents per ton. Our material costs flucuate anywhere from 5 to 16 cents per ton in the different properties. There are a few questions that I would like to have Mr. Whiteside explain, if he possibly can.

It would be interesting to know the tonnage per man on these two types of conveyors as explained by Mr. Whiteside in his paper. What I mean by that, including everybody that does work around the conveyors, like the machine men, the blasters, the moving and maintenance men, and so forth. Also, I would like to know whether there is much breakage of ropes in the Jones type of conveyor from wear or abuse.

Cleaning STRIP-MINED Coal

By William H. Stewart *

DURING the first few years of strip mining, little or no attention was paid to the preparation of the coal. The main idea was low cost of production, and as long as the coal could be sold at a profit, the operator did not worry about the quality of his product. In consequence, as strip mining became more general, coal from strip pits had to be sold at a lower price than that from the deep mines. Even at a much cheaper price per ton, "strip coal," as it was called, did not have much standing with the consumer.

The operator was entirely to blame for this condition. His main thought was tonnage, so his cost could be kept low, and all his skill and energy was used to get this result. For this reason the development of shovels, haulage, and methods of production have progressed more rapidly than preparation.

The company with which I am connected started its first operation in the fall of 1917, and through the foresight of its president we decided to give as much attention to preparing the coal as to the production. This could be done, and while it would naturally increase our cost, it would enable us to overcome the prejudice of the consumer and eventually we would be able to increase our average selling price.

With the idea of quality before us—as each new operation was started—we succeeded in rectifying our mistakes and applying new practices and equipment until we now feel that the stigma of strip coal has been removed and our customers are satisfied. This has resulted in increased running time for our mines and better realization, which naturally offsets the added investment.

The latest operation for preparing strip coal in Indiana consists of a tipple and washer designed and built by the Link-Belt Company and incorporating our own engineers' ideas of efficiency and economy of operation. No attempt will be made to go into details as to methods of stripping or handling in the pit.

The coal mined is Indiana No. 6 and a description of the coal before loading into pit cars will enable one, who is not familiar with this particular bed, to understand why such a plant was necessary. The coal averages about 63 in. in thickness and throughout the entire field has three dirt bands. These bands are a soft shale and vary from ¼ in. to 3 in. in thickness. In addition, the bed contains a fair amount of sulphur, both in lenses or sheets and kidneys. This sulphur runs heavy in some parts of the pit, while in other sections there is practically none. The dirt bands break up in loading and go mainly in the sizes from 1¼ in. down. Horsebacks—locally known as rolls—of a rather hard shale and varying from 6 in. to 10 or 12 ft. in width, are common. These rolls if very small (12 in. or under), are loaded with the coal, while those of any size, are piled to one side by the loading shovel. Also, when loading with a power shovel some dirt is bound to be loaded unless instructions are given to keep the machine off the bottom, but if this practice is followed many tons of coal are lost, so it is advisable to remove these impurities at the tipple, and mine all coal possible.

At most operations it has always been the practice to clean the surface of the coal thoroughly before loading. This was done in various ways—by men with shovels and wire brushes, compressed air for blowing the dirt away and slip or Fresno scrapers. In some pits, the top coal, if it contained many impurities, was removed entirely by the stripping shovel. If the coal was screened, picking the coarse sizes was resorted to, but in practically all instances the fine coal was neglected. It was considered a necessary evil and was sold for what it would bring.

In the mine we are describing no particular care is taken to clean the coal before loading into pit cars. A caterpillar tractor equipped with a bulldozer is used for pushing the loose dirt onto the spoil or back against the high wall and only in exceptional cases are men with shovels used to clean the surface.

The coal is then dug without blasting, with a Bucyrus-Erie 75-B electric shovel, and loaded into 35-ton Sanford-Day bottom-dump cars, which are dumped into a 200-ton concrete hopper at the tipple. It is then fed onto a 48-in. flight conveyor 141-ft. long center to center, with capacity of approximately 350 tons per hour, by a reciprocating feeder. This feed is driven by a slip-ring motor and also has an adjustable stroke, and in this way the coal may be delivered to the screens at a varying rate. This has been found advisable because if there is a particularly dirty place in the pit, all of it will come at once, and unless the feed be slowed, causes trouble in cleaning.

The flight conveyor delivers the run of mine to the shaker screens. These screens are rather small as only two different size openings are used, 4 and 6 in. Everything under 4 in. in size is screened out and carried to the washer, while the 4 by 6-in. and 6-in. lump are delivered to picking tables where the impurities are removed by hand. This refuse is carried on an apron conveyor and is in turn repicked. All pieces that do not contain enough coal to warrant re-claiming are thrown into another conveyor and discharged into the refuse bin. The balance of the rejected material is crushed into a minus 2½-in. size and carried back to the washer and washed with the other coal that comes direct from the shakers.

The tipple is designed to load five sizes at once and equipped with all necessary loading booms, mixing conveyors and crushers to fill the requirements of the consumer. No detail has been neglected to insure economy of operation together with the highest degree of cleanliness and sizing, and orders are given all foremen that while tonnage is vital to our operations, preparation is just as important, and the standard must be maintained even if at times it means a curtailment of tonnage.

Before going into the details of the washer and the results obtained, it might be well to explain the reasons for building these plants at our operations. Analyses made at different times showed 16 to 24 percent ash in our 1¼-in. screenings, and from 13 to 16 percent ash in the other sizes up to 4 in. In screen analyses made we found that the impurities were nearly evenly divided among the various sizes, and for that reason there was absolutely no chance to re-screen and waste any particular size to reduce the ash content of the remaining product, so it naturally resulted in washing as being the only solution of our difficulty. After a great deal of experimentation and testing it was decided that there would be no trouble in getting the ash in all sizes below 9 percent, and we have found in actual practice that this can be done.

Before deciding upon the use of jigs and the wet system, we investigated the possibilities of cleaning by the dry process, but owing to the impossibility of having a fairly dry coal this was thought impracticable. When loading in strip pits the operation can not halt because of weather conditions, so during heavy rains and snows the coal will be delivered to the tipple with a varying amount of moisture. Also, in our own particular case, the dirt bands and horsebacks, when wet, have a tendency to blind any screen with a fairly small opening, and for that reason we did not want to size before cleaning.

Installed in our first washers were a well-known type of plunger jig which gave good results. The main drawback was lack of capacity for each unit, owing to the high ash content of our raw coal. If the coal was fed slow on these jigs the product was all right, but if they were forced, which was imperative at times, it was difficult to make a good separation. To keep the coal clean and up to the standard required there was a large percentage of clean coal in the refuse. Also, it was found that better results were obtained by sizing the raw coal before washing, and having as near as possible the same size coal fed to each jig.

In the summer of 1928 it was decided to enlarge one of our plants, and a Link-Belt Simon-Carves washer box was erected to work on the 1¼-in. screenings, while the plunger jigs were all put on the 1¼ by 4-in. size. The results obtained in this installation caused us to put in two Simon-Carves, each having a capacity of 120 tons per hour, at the new mine in 1929. There were several reasons for our decision to specify these washers,

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namely: simple adjustment and easier supervision, no sizing before washing, low costs both as to maintenance and operating, good water circulating system and uniform quality of the washed product.

These washer boxes are constructed entirely of steel and use air as the pulsating medium. They are simple in operation and the maintenance cost is very low as all parts are slow moving. Any change in the movement of the bed can be made at once by the adjustment of the air or water valves, while with the old type of jig, to change the stroke of the plungers required a great deal of time and labor and could not be done during the washing process without stopping. Consequently, at times our washed product would have been better if the jigs could have been set to counteract the conditions arising that day in the pit.

As I have stated elsewhere, all sizes passing through a 4-in. round opening are carried by a flight conveyor and fed direct into these wash boxes, at a varying rate. The tonnage delivered depends again upon pit conditions, for if the coal is very dirty and runs heavy in fines, which it is liable to do at various times, the feed of raw coal must be regulated so as to keep the finished product within the standards set.

After passing through the wash boxes the washed coal is carried in a launder to the classifying screens. There it is sprayed and rinsed with clean water to remove any stain which is liable to occur from the drying of the wash water. The various sizes are taken from the screens by spiral chutes to the loading booms or mixing conveyor, with the exception of the minus ¾-in. which size is delivered into a launder that carries it to the dewatering screens, which are jigging trays fitted with wedge wire screens with ½ millimeter opening. After passing over these screens the fines are moderately dry and are then mixed with the other sizes as wanted.

At each operation one man is engaged in making float-and-sink tests during the day's run. A Delatester is used with the liquid at 1.42 specific gravity, which is the separation point of the coal and refuse. A curve has been plotted from ash analyses made from samples of 100 percent float to 80 percent float. At anytime the tests show over 9 percent ash on the curve, the washer operator is immediately notified and the action of the washer box is corrected to bring the ash to below 9 percent. While 9 percent ash is our maximum, seldom do we go that high, our average being about 8.5 percent on all sizes.

We have found by experience that in washing number 6 coal with so much clay and shale mixed in it that an adequate supply of fresh water is a necessity. The water for this operation is furnished by two American deep-well turbine pumps, each with a capacity of 450 gallons per minute, either one of which is capable of supplying enough water, so one is kept in reserve. These pumps in turn deliver to a high head centrifugal which pumps through a mile of 8-in. line to the washer. The valves in our settling tanks are opened and enough dirty water is released to allow for the fresh make-up water. We could operate after a fashion with a smaller amount of make-up water, but it would be impossible to get the same results, as the clay and shale in our refuse soon goes into solution and causes trouble with our de-watering screens besides coating the washed coal with a thin film of dirt which destroys its appearance.

Seventy percent of the fines lost through dewatering screens and washboxes will pass a number 10 screen and about 25 percent will pass a number 100 screen; no attempt up to the present time has been made to reclaim them. Our waste water runs through a launder to a settling basin and will average about 7.6 percent solids by weight of which 50 percent will float on a 1.42 specific gravity liquid. We have not thought it advisable to recover these fines at the present time owing to the great additional investment for a comparatively small saving.

Our loss in refuse from these washers is about 15.5 percent, of which 5 percent is float, or in other words, our refuse contains about 5 percent of merchantable coal but it has been impossible to get it lower and maintain quality. At first our loss was much greater, but by continued experimentation in various ways with the feed, air and water, we have finally reached this result and whether we can go beyond this point is questionable.

The refuse from washer and picking tables is carried by a drag conveyor to a large bin where it is discharged into side dump cars and hauled outside of the coal area and dumped. It is then dragged into large piles with an electric-operated drag scraper. This refuse was formerly dumped in the pit, but the time lost in loading caused by the movements of these cars forced us to keep the pit tracks for movement of coal only.

We also have about the same percentage of refuse from the hand-picked coal as from the washed product. This amount is naturally large because, as I have stated, no particular care is taken in the pit to clean the coal before loading. This practice effects a considerable economy through labor saved in the pit.

The following table gives the results of the washer for the first three months of 1930:

Month	Coal Washed, tons	Percent Coal Graded No. 1	Refuse, tons	Percent Refuse from Washer	Percent Float in Refuse 1.42 Sp. Gr.	Average Ash in Washed Coal Percent
January	23,855.5	100	6,480	15.52	5.10	8.34
February	19,171.0	100	4,356	15.15	4.95	8.33
March	16,762.8	100	4,390	15.53	5.00	8.36
Total	59,789.3	100	15,226	15.40	5.02	8.34

No attempt is made to go into a detail cost per ton of coal prepared for sale at these plants as it is almost impossible to figure. Of course, the actual labor and maintenance cost plus the amortization of the investment are kept, but to offset this are the decreased cost of labor cleaning in the pits and the reclaiming of dirty coal both in the tipple and pit that otherwise must be cast aside. These credits are important, but cannot readily be converted into cents per ton.

Another item of cost and also a problem of operating and marketing is the freezing of the washed fine coal during the winter months. Our 1¼-in. and under coal has about 8 percent moisture when first loaded, but if allowed to drain 24 hours this is decreased to about 5.5 percent. During the winter months these loaded cars arrive at destination with the contents frozen just enough to cause trouble in unloading unless the customer is equipped with steam for use in thawing. Of course, there are on the market various types of centrifugal dryers, but owing to the added investment and operating costs, we have not satisfied ourselves that they are vital to our operations. Our organization is working on this problem and we are much encouraged with the success obtained this past winter. Although results were not 100 percent perfect, we feel that next year will show a great improvement in our process.

There are two reasons for a preparation plant: (1) To make a poor coal salable and where the cost of operation is merely added to the actual market price of the raw coal. (2) To make a good coal better and where the added realization will show a profit on the investment. In the first case the simplest and most economical plant possible, both in first cost and operating, is desirable, while in the second case, a great deal of investigation both in marketing and operating problems are necessary before a decision is made as to the kind of plant required.

At the best a strip operation is limited as to available tonnage and its life is not long in comparison with some underground mines, so before deciding what course to take a thorough study of this particular operation must be made.

Your selling organization must know how and at the approximate price they can dispose of the product; the operating organization must know the approximate cost of operation, the tonnage available, the percentage of loss and whether they will be able to keep the cleaned and washed product to the standard required. This last is important for only with a uniform product are you going to be able to maintain your market.

A great deal of preliminary work in connection with a new operation can, and is, done in the laboratory, but we have found that a practical knowledge of the particular coal in question, and of its varied size and quality due to the light overburden is the main factor in determining the type of plant and methods used.

In conclusion, I wish to state that from our own experience, and possibly some from our neighbors, washers and elaborate preparation equipment are a necessity for some but for others, who have a fairly clean coal, the added realization will never pay their investment.

CLEANING COAL at the Consolidation Coal Company

By R. E. Rightmire *

THE Acosta coal-cleaning plant of the Consolidation Coal Company is near Somerset, in Somerset County, south-central Pennsylvania, and was installed to clean mechanically the minus 2½-in. size of Jenner coal as made by shaker screens equipped with lipped plates and long slot openings.

Jenner coal is produced from the C Prime or Upper Kittanning bed, has the columnar or fingery structure, mines in fair average size for coals of this physical character, and by reason of its average volatile matter content of approximately 17 percent is classed with the so-called smokeless coals.

From a study of sizing and float-and-sink tests, laboratory analyses, test-plant results, and the conditions affecting the production and marketing of Jenner coal, the decision was reached as to the system of cleaning apparently offering the greatest advantages in meeting the conditions.

The Peale-Davis pneumo-gravity system (dry cleaning) was selected, and the cleaning plant, including a new tipple of 3,000 tons daily capacity, was built and erected by the Fairmont Mining Machinery company, of Fairmont, W. Va.

Under the Peale-Davis system screening of the product to be cleaned into a number of different sizes for cleaning purposes is unnecessary. This is a decided advantage in that much of the degredation into smaller sizes which results when much presizing is necessary is avoided.

The tipple and cleaning plant are built side by side so that the raw coal reaches the cleaning plant with minimum conveyor travel. The principal cleaning-plant equipment consists of the following:

1. One primary table of 300 tons hourly capacity, equipped with a fan and airduct and fed from a bin of 150 tons storage capacity.

2. One retreatment table of 100 tons hourly capacity, equipped with a fan and airduct and fed from a bin of 75 tons storage capacity.

3. A dust chamber, directly over the primary and retreatment tables, which receives the dust-laden air coming from the tables. Due to the large area of this chamber, allowing expansion of the air current from the tables, the dust is largely precipitated and collected in storage spaces provided.

4. Conveyors and elevators to handle the raw coal, cleaned coal, and refuse properly.

5. Two crushers to break to small sizes pieces of coal and impurities bound together which may be found in the raw coal or in the middlings or refuse product from the tables.

The coal comes to the tipple in mine cars, which dump into a weighing pan from which it is passed onto a conveyor carrying it to a shaking screen, which sizes the mine-run coal into 2½-in. lump and minus 2½-in. coal.

The 2½-in. lump passes over the screen onto a picking table conveyor, where it is hand picked for removal of impurities and passes along to a loading boom, from which it can be loaded as straight lump for shipments, or it can be mixed with the cleaned minus 2½-in. coal in proper proportion for straight mine-run shipments.

The minus 2½-in. coal passes through the screen to an elevating conveyor, which carries it to the 150-ton capacity bin, which is usually called the raw-coal or primary bin. From this bin the raw or primary coal is fed uniformly onto the primary table by means of a rotary feeder.

The primary table operates with a reciprocating or shaking motion delivered by eccentrics mounted on a motor-driven shaft, and the air pressure for cleaning is supplied by a fan which is also electrically driven. The top of the table is covered with strips of thin metal sheeting or cloth called the zoning, which has small perforations of the proper sizes for different sections of the table.

On top of the zoning, strips or riffles of proper height are placed diagonally to the width of the table, which act as deflectors for the refuse in the cleaning process; the lighter clean coal flowing over the riffles to the clean-coal discharge and the free impurities or refuse collecting at the bottom of the riffles and moving along them until discharged from the cleaning table into the refuse boxes.

The air pressure from the fan is delivered to an airduct running lengthwise under the table and is controlled by fan regulation and by means of regulated openings in a plate below the deck or zoning plane of the table.

The separation of the coal and free impurities is accomplished (1) by the shaking or reciprocating motion of the table, (2) by the inclination of the table sidewise, lengthwise or both, as may be necessary for proper cleaning, (3) by the action of the diagonal strips or riffles, and (4) by the action of the air pressure.

The coal fed to the primary table is discharged from it in three classified products: (1) Cleaned coal, (2) middlings, and (3) primary refuse.

The cleaned coal is handled by conveyors which deliver it to the loading boom for reassembling with the lump for run-of-mine shipments or to a chute for loading separately into railroad cars.

The middlings, which are partly coal and partly refuse, are returned to the primary raw coal-feed bin, from which they pass to the primary table for further cleaning.

The primary refuse is conveyed to the storage bin, from which the retreatment table is fed.

The coal fed to the retreatment table leaves it in three classified products: (1) Cleaned coal, (2) middlings, and (3) final refuse. The cleaned coal is handled along with and in the same manner as the primary clean, the middlings are recirculated for further cleaning, and the final refuse is passed to the rock disposal.

Control of plant operation is of prime importance in maintaining the desired standard of product and maximum efficiency in operation; this is accomplished as follows:

1. By frequent float-and-sink tests of the various products and ash analyses of same; these tests give the quick information necessary to determine the control of cleaning plant operation. Necessary equipment and facilities are installed for making these tests quickly and often.

2. By taking representative samples of the various products at frequent intervals. These samples are put through a Sturtevant grinder and sampling machine which crushes the coal to ⅛-in. size and separates approximately 10 percent of the total for sample, which is quartered down until the desired quantity is obtained for making up the sample for analysis. From these individual samples a composite sample of the day's run is obtained. The rejected portions of the samples, except for final refuse, are returned to the clean coal or table feed, according to the product represented.

3. By observation of railroad-car loading to make certain that size requirements are met when making run-of-mine shipments.

* Engineer of Tests, Consolidation Coal Co.

An interesting model exhibited in full operation at the Exposition

Cleaning Anthracite Coal

By Paul Sterling *

IT IS a remarkable fact, that the users of the domestic sizes of anthracite coal, know less about the quality and combustion of the product they purchase and burn, than of any other commodity that enters into the home. They are far more familiar with the miles per gallon of gas used in their auto, or the latest development in radio or aviation, than with the fundamental home necessity, for true comfort, which is heat.

Our comfortably heated homes, electric lighted and radio equipped, complex transportation systems and our many manufacturing activities, all involve a high development of the metallurgical arts, which are only possible by the use of coal. The manufacturing of iron, steel and other ores is fundamental to our national prosperity, and the fact that we have adequate resources in coal accounts, in no small way, to our great development.

It seems to me an obvious fact that our national happiness and prosperity, and especially that of the thickly populated and industrial sections of our great United States, tributary to the anthracite coal fields, is due, in no small degree, to the satisfactory anthracite smokeless coal used domestically throughout that section during its period of greatest development.

During the World War, with its tremendous coal demands, the supply of anthracite was inadequate, and many former users, especially living in Government restricted territory, had to find substitutes, and once found, and with the help of skillful salesmen, the inroads into the anthracite tonnage became marked. It is also a fact that the high preparation standards of pre-war days was lowered during the war, in order to increase the supply. This caused dissatisfaction, and loss of some former customers, and the first thing necessary in regaining our impaired market is the reestablishment of confidence in anthracite as a fuel, in the minds of the public. If this be true, then let me impress upon you that there never was a time when the anthracite producers were making greater efforts to clean and size their coal and give the trade exactly what they think they want, which is bright, shiny, glassy-looking coal.

Their demands are responsible for an economic loss for the operators and higher price for the users, for in order to meet competition and supply the critical trade with "Quality Anthracite" the mining companies are sending to the refuse banks hundreds of tons of combustible material, and just because it does not look good to the trade. Yet this rejected coal was formerly commercial, and acceptable to the users. The direct result of this waste is a "Quality Anthracite Coal" which burns readily; in fact, so much so, that in many cases we are asked, "What is the matter with the coal, it burns up too fast?"

When confidence is restored so that the consumers will accept "Anthracite Combustible," as recommended by the operators, they will ship a product, properly balanced in the percentage of the various grades or gravities of coal, to give a low ash, and at the same time sufficient bone coal to properly retard rapid burning, and yet hold its fire and heat over long periods, reducing the number of firings and the amount of attention.

Experience indicates that approximately 12 percent ash domestic anthracite is best adapted for general use, and that lower ash products, as manufactured today, burns rapidly, will not easily respond to dampening, and in consequence the consumption is excessive as compared to 12 percent ash anthracite. *Tables I and II* show the sink and float of the various sizes, the percent by weight of total recovery, and the percent of ash content for each recovery. *Table I* is from the northern, while *Table II* is from the middle anthracite field.

Table I shows that "Anthracite Combustible," containing approximately 12 percent ash, floats at 2.00 gravity, whereas "Quality Anthracite" is floated around 1.60 to 1.65 gravity, resulting in a loss of approximately 15 percent combustible when compared with the former.

In the northern field about 68 percent of the shipments are egg to nut sizes, and are the only ones sold at a profit, so the increase yield due to recovery at 2.00 specific gravity would be approximately 15 x 68 percent, or 10 percent.

Table II indicates that a recovery at 2.00 gravity for "Anthracite Combustible," and when compared to "Quality Anthracite" at 1.70 to 1.75 gravity the increase yield is only 10 percent all sizes, and for egg to nut is only 10 percent of 63 percent, equal to approximately 6 percent.

Each increase of 1 percent in the prepared sizes (egg to nut) is approximately equal to 8 cents per ton additional revenue, so that the total increase return would be 80 cents and 50 cents per ton, respectively, for the northern and middle fields. The average revenue based on tonnage would certainly be around 65 cents.

This additional tonnage, when manufacturing "Anthracite Combustible," would be obtained, without any added expense; as a matter of fact, there should be a slight reduction, and eventually the users would benefit to the extent of at least 75 cents per ton, if they would be convinced of the superior quality of "Anthracite Combustible" as compared to "Quality Anthracite."

Last year the Dorrance Colliery of the Lehigh Valley Coal Company mined 195,045 mine cars, with a prepared coal yield (egg to nut), of 1.865 tons per 100 cu. ft. per mine car when preparing "Quality Anthracite." If they had manufactured "Anthracite Combustible," there would have been an increase yield of .19 ton per 100 cu. ft., equal to .2 ton per mine car, or a total of 39,000 tons per year.

Similarly, at their Hazleton shaft plant, the prepared yield of 1.406 tons per 100 cu. ft. would be increased by .089 ton per car, or for an output of 120,684 cars 10,800 tons additional recovery.

The total estimated additional prepared recovery for the Lehigh Valley Coal Company would have been 420,000 tons for 1929.

These astounding savings, when applied to the entire anthracite field for the prepared sizes only, and applying the estimated saving of 75 cents per ton on a total annual production of 60,000,000 tons, of which 40,000,000 tons would be egg to nut sizes, would result in a saving to the anthracite users of $30,000,000 when using anthracite combustible.

The ideal preparation method to remove impurities from the r. o. m. coal to produce quality anthracite is hand picking of the prepared sizes. With this system the objectionale pieces which will not pass visual inspection, but will float with the low gravity coal, can be eliminated. However, this antiquated method would result in a prohibitive cost today and, in addition, it would be impractical when mining the less desirable beds, as compared with the rich, clean veins once available and which were practically free of impurities.

Principally for these reasons mechanical cleaning has replaced hand picking, and the following classifications, in my opinion, cover the successful systems:

(1) Dry mechanical cleaners, such as the Emory and Pardee spiral picker, depending on sliding friction as the means of separation. Largely due to wet condition in the r. o. m., dry cleaning has been supplanted by wet washing.

(2) The jig, both pan and plunger,

* Mechanical Engineer, Lehigh Valley Coal Co.

TABLE I

Sp. Gr. Sink	Sp. Gr. Float	Egg Wgt.	Egg Ash	Stove Wgt.	Stove Ash	Nut Wgt.	Nut Ash	Pea Wgt.	Pea Ash	Buck Wgt.	Buck Ash
	1.50	52.3	5.7	58 2	5.8	59.3	5.6	66.7	5.5	59.6	5.3
1.50	1.60	83.0	9.3	82.4	7.6	80.6	7.5	81.8	6.9	81.6	7.4
1.60	1.75	95.1	11 2	92.4	9.3	91.8	9.6	90.7	8.7	89.8	9.2
1.75	2.00	98.2	12	96.2	10.4	95.0	10.6	94 0	9.9	93.3	10.6
2.00		100	13.1	100	12.7	100	13.7	100	14	100	15

TABLE II

Sp. Gr. Sink	Sp. Gr. Float	Egg Wgt.	Egg Ash	Stove Wgt.	Stove Ash	Nut Wgt.	Nut Ash	Pea Wgt.	Pea Ash	Buck Wgt.	Buck Ash
	1.60	45.5	5.5	50.5	4.0	40.9	4.7	46.5	5.1	42	4.6
1.60	1.75	81.5	8.6	80.5	7.3	77.7	9 0	77.0	8.4	73	8.0
1.75	1.90	91.5	11.0	87.5	9.3	43.4	10.5	83.2	10.5	80	10.2
1.90	2.00	93.8	12.0	90.9	10.8	86.5	11.6	87.0	12.0	84.6	12.6
2.00		100	15.0	100	17.3	100	21.0	100	20.7	100	22.6

are used, and the type selected seems to depend largely on the personal equation. When "Quality Anthracite" is produced, double jigging is recommended for good recovery.

(3) Rheolaveur washers, where separation is effected by the cumulative influence of specific gravity, sliding friction and shape of piece.

(4) Chance, which depends on specific gravity alone, and when operating at low gravities the refuse should be usually retreated by some means for best results.

(5) Concentrating tables for fuse sizes, which take advantage as well as the specific gravity.

(6) The Hydrotator, for fine coal, depends for classification in an ascending current of water.

(7) The Menzie hydrotator, which is essentially a hundred settling classifier.

(8) The Ayres mechanical picker, which has had limited use on coal, has met with some success in removing free ash, especially from bank coal.

Any of these processes will clean coal from its impurities in a more or less complete manner.

The essential difference between the various processes is quantitative and not qualitative.

Excellent papers on the results obtained with jigs, Chance cones and rheolaveur were ably presented before the Mining Congress by Mr. Edward Flynn, of the Lehigh Coal and Navigation Company; Mr. William Lesser, of the Madeira-Hill Company; and Mr. Shelby Dimmick, of the Glen Alden Coal Company, within the last three years, so there is little to add to the subject. I will, however, touch upon each briefly.

Little definite advance has been accomplished with jigs for exact separation, and no particular interest has been given to the ratio of diameters for high recovery or efficiency. The presizing for jigging depends upon the screen mesh used in preparing the various sizes, and the approximate ratios of diameter of the largest to the smallest piece is: Egg, 2.0; stove, 2.4; nut, 3.9; pea, 2.3. For high recovery close sizing is necessary; for example, if refuse is 2.00 gravity and the coal 1.50, then the ratio of diameter should be 2, at 1.6 gravity 1 2/3, at 1.75 gravity 1 1/3, at 1.90 gravity 1.1. In other words, for egg coal over 2⅜-in. rd., should pass through 3 5/16-in. rd., for 1.50 gravity recovery, over 2⅜-in. rd. and through 3 1/16-in. for 1.60 gravity over 2⅜ and through 2⅞-in. for 1.75 gravity and over 2⅜ and through 2½-in. rd. for 1.90 recovery. Corresponding figures may be calculated for stove, nut and pea. It is obvious that it is necessary to split the sizes for high recovery and remix after jigging. It also seems advisable to reduce the suction as, at high velocities of the descending water, the less dense of equal pieces at the beginning and during motion sometime fall through the greater distance. In my opinion, experimentation along theoretical lines might lead to a decided improvement in jig design for the production of quality anthracite.

The Chance process has definitely improved its mechanical operation by the elimination of the refuse sump and hydraulic seal on the slate discharge. I believe the first successful installation of this method was made by the writer at the Chauncy Colliery of the George F. Lee Coal Company in 1924. This change has removed a high cost unit of the Chance system and reduced the head of the recirculating pump, resulting in a slight saving in power. Electric control of the refuse discharge gates is also an improvement.

The latest installation of a rheolaveur plant at the Dorrance Colliery of The Lehigh Valley Coal Company replaced an antiquated dry breaker equipped with spiral separators supplemented by hand pickers. Due to the fact that the old breaker could not be abandoned until the new one was started, and also that the new plant was to occupy a portion of the old breaker site, construction was slow. I expect that the plant will be completed about June 1. However, the "Rheo" machinery started running on January 16, 1930, and has continued without interruption since, and results seem to justify the system. The plant is too young to give operating cost and data over a period of time. There is, however, one outstanding and definite result compared with the old breaker, and that is an increase in the prepared yield. In 1928 it was 1.890 and in 1929, 1.865 tons per 100 cu. ft. of mine-car capacity. This has jumped to slightly over 2.00 tons per 100 cu. ft., a gain of approximately .15 ton per 100 cu. ft., or .172 ton per mine car equal to 38,500 tons per year based on 1929 mine cars dumped. The interesting fact is that we are manufacturing "Quality Anthracite" at around 1.60 specific gravity, and the yield has gone up in spite of the reduced percentage of allowable bone and impurities, which indicates the high recovery possible with this system.

Concentrating tables, the hydrotator and Menzie hydro-separator, are generally used on fine sizes. Recent tests indicate that the Menzie separator may be adapted on sizes up to nut. All these machines give excellent results when properly operated. The personal equation is, in my opinion, a great factor in the selection.

We are very well supplied with classification machines to suit almost any problem, condition or pocketbook. The machines are not perfect, since they are all manually controlled, but the attendance has been reduced to a minimum, so that one man can control and operate a 3,000-ton-per-day machine. While high recovery is important, and not to be neglected, it is not, in my opinion, nearly as monmentous as the crushing and screening of coal. More money can be lost by inefficient breaking of coal in the present-day rolls than is ever wasted on the refuse dump of an average breaker. I know we have put great stress on the coal going to waste and have been more or less indifferent to the more important problem of economic breaking into sizes and efficient screens. I have no cure to offer, but, having given the subject serious thought, I do have some ideas which I hope will be soon tried out. To give you some idea of the loss as compared with maximum recovery, take 1,000 tons of feed containing 14.5 refuse, or 855 tons of coal and 145 tons refuse. An average refuse sample would contain 3 to 5 percent of coal. I will use 5 percent, or an approximate total of 7.25 tons, of which 65 percent is prepared and 35 percent pea and smaller. The approximate value of the coal in the refuse is $45. If the 855 tons of coal were shipped in sizes from "broken" down, the return would approximate $6,200. If, due to lack of demand, the larger sizes are crushed to stove and smaller, the value of the resulting product would be $6,075, or a loss due to degradation of $125, or nearly three times the saving due to 100 percent recovery. These figures, I believe, fairly represent the loss, so you can realize the importance of trying to improve.

The present so-called standard toothed roll should give, in general, 85 to 90 percent of prepared sizes and seems about as high as can be expected. The slow speed, about 250 ft. per minute, cuts down the velocity of fall onto the chute below to about 1 ft. head. The total fall is approximately 2 ft. plus 1 ft. or 3 ft. The breakage due to this head into pea and smaller is approximately 2½ percent for egg, 2.8 percent for stove, and 5.2 percent for nut. If this breakage alone can be eliminated, there would be a handsome saving. I have designed a set of rolls consisting of a smooth and a toothed roll, geared in the ordinary way and set on an incline of 45 degrees. The smooth roll is an anvil on which the coal is broken by the toothed roll. The product from the roll slides off the smooth roll onto a plate, eliminating practically all drop and consequently breakage. Shop tests gave up to 93 percent prepared sizes when breaking through one size only. I am thoroughly convinced the most efficient results are obtained when each size is broken to the next smaller. I have made hundreds of roll tests and have come to believe that the ideal roll or "breaker" will be one in which the pieces to be broken will be supported on its ends and broken in two by a cutter bar, which will strike the supported piece of coal midway between the supports. Laboratory test made by hand indicates an efficiency approaching 100 percent. I realize the difficulty of designing such a coal breaker, but believe the preliminary results warrant a study along these lines.

I have tested almost every type of machine used to break or crush material, gyratory and jaw crushers, single-roll toothed crushers, smooth-roll brakes, ring crushers, pulverizers, stamp mills, steam hammers, and so on. But of all these the present design seems to me the most practical to date. The diameter within limits seems to have little effect on the results, but slow periphery speed and sharp-pointed teeth do have a decided influence on the prepared yield.

In order to produce quality sized coal, it is of utmost importance to develop, if possible, a more efficient screen. The average efficiency in commercial practice is 60 percent, and 75 percent is extremely good, and 90 percent about as high as can be reached by hand screening, yet, in spite of this fact, we adopt a standard mesh, and then go on and specify an impossible limit of undersize; and, in order to get results, we must use a larger mesh. This is particularly true of nut coal. We agree to use say ¾-in. mesh, and prepare a product containing only 5 percent undersize or pea coal. In order to get results, we must use say 13/16-in. mesh, with the result that we lose some of the high priced nut coal into the undersize. The whole business should be run on a practical commercial basis to produce a practical combustible product. The undersize, within limits, will not have any injurious effects on the burning qualities of the mixture, and the product is 100 percent combustible.

We have installed extremely long shakers to remove the undersize, but, if

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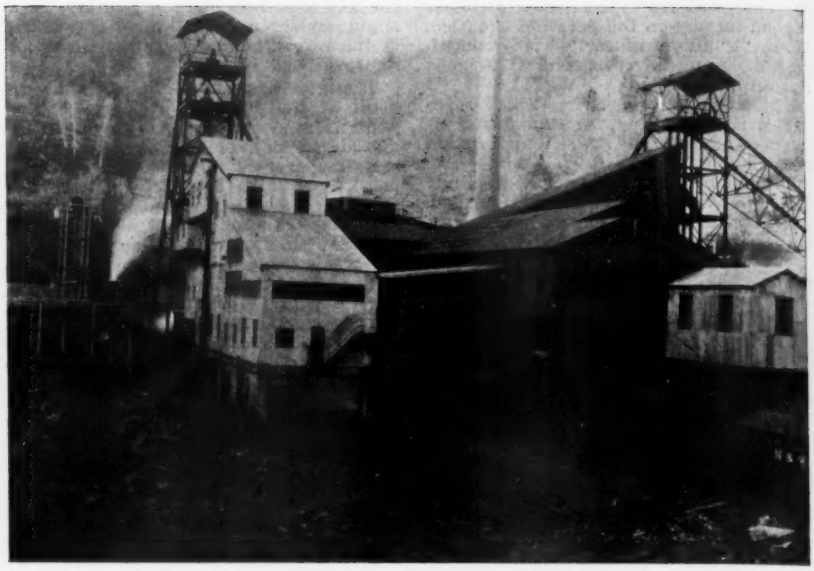
Cleaning Coal at the Carswell Plant—Houston Collieries

By **Alder F. Castanoli** *



THE Houston Collieries Company have recently completed improvements on top works at the Carswell mine. These improvements include modernization of power generation, adequate refusal disposal and a modern coal-cleaning plant. Each of these improvements is rather unique and contributed in no small measure towards making this plant the most thoroughly mechanical, as well as one of the best equipped from a preparation standpoint in the Pocahontas field.

A number of difficulties had to be surmounted. First and greatest of these was the inherent characteristics of the coal, which is hoisted from two shafts, one serving the Pocahontas No. 3 seam and the other the Pocahontas No. 4 seam. The coal mined has the typical Pocahontas friability. Careful mining practice has kept the slack below the minimum ash requirement, but in the raw coal above ½ in. considerable bone and slate coming from a bone parting in No. 3 seam, 3 to 5 in. thick, and several thinner bone strata in No. 4 seam must be removed. Second, the refuse disposal system was entirely inadequate. Third, the boilers equipped with over-feed stokers were unsuitable for the consumption of bone as a fuel.

However, a thoroughly modern tipple was included in the mine equipment before the present improvements were undertaken. Picking table area was amply sufficient, but without mechanical preparation, the sizes from ½ in. to 6 in. were too high and irregular in ash to be advantageously marketed. Hand picking proved uneconomical. The material rejected by the pickers was high in coal value, the clean coal was high in ash and spotty, and tipple operation had to be interrupted scores of times on some days to allow pickers to keep pace with the feed surges. The logical disposition of bone rejected by the hand pickers would be to send it to the boiler house as a low-grade fuel, but the human factor entering into the preparation of even this inferior fuel was found to be too unreliable.

The decision to modernize the entire top works and to install a modern coal-cleaning plant, with facilities for preparing a suitable boiler fuel, was influenced by these conditions, as well as a thorough study of the characteristics of the coal.

The original system of refuse disposal consisted of hauling rocks from the tipple to near-by low ground. Aside from the fact that this practice was very expensive, it had the further disadvantage of using all the available spaces in a short length of time. These considerations led to the construction of an aerial tramway designed to provide an ecomonical means of refuse disposal for the life of the plant. As now arranged, refuse hoisted in mine cars from the two shafts, refuse from the washing and lump-picking table, as well as the boiler ashes, are collected by means of a system of conveyors into one central bin and subsequently loaded by an apron feeder in tramway buckets and automatically dumped into a deep valley one-half a mile distant. This requires the part-time labor of one man, is low in capital cost, and has practically no maintenance.

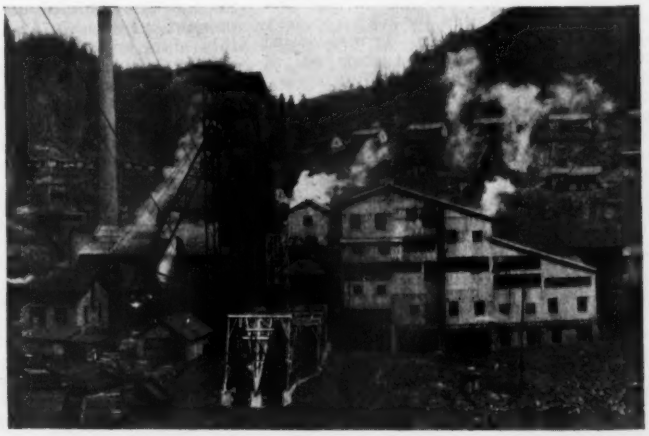
The washing plant is a Rheolaveur sealed discharge plant, designed to handle ½ in. x 5 in. coal, although at present it is cleaning up to 6 in. Installed washing capacity is 225 tons per hour. Recently there was dumped at this plant a total of 2,614 tons, meaning that an average of approximately 500 tons per hour actual running time was maintained. Of this approximately 200 tons per hour was handled by the washery, leaving no doubt as to its ultimate capacity.

The accompanying diagram shows in detail the flow of water and coal through the tipple and washing plant. Coal from the two shafts is fed onto the main shaking screens by an apron feeder. Here, with the aid of Hummer screens, the raw coal is sized into 0 x ½-in. slack, which is loaded dry without further preparation, ½-in. x 6-in. coal, which constitutes the feed to the washing plant, and a plus 6-in. lump, which is hand picked and also loaded directly.

The washing plant proper consists of one two-box primary launder and one two-box secondary or rewash launder disposed parallel to each other on the same level. Each Rheo box is served by one compartment of a double compartment sealed boot elevator. This makes necessary only two drives for the Rheolaveur launders. Primary refuse from the first box of the main launder goes to the rewash launder. Material discharged by the second box of the primary launder is returned as regulating material to the head of the same launder.

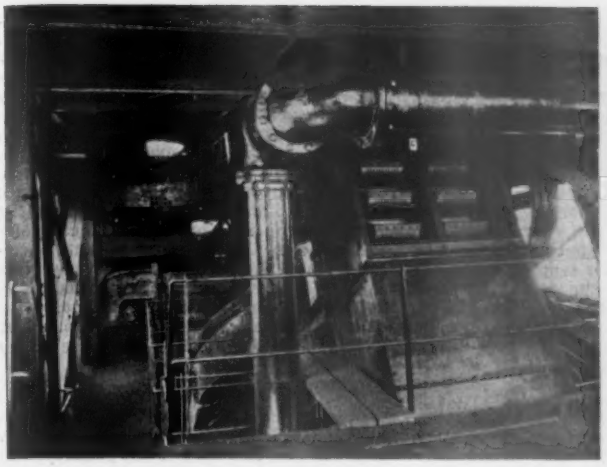
Final refuse from the first box of the rewash launder is sent to the refuse bin after 0 x ⅝-in. material is partially removed by the refuse shaker and returned to the rewash launder as a regulating material. The newly built aerial tramway disposes of the refuse. Repeated analyses show this to be in excess of 60 percent ash.

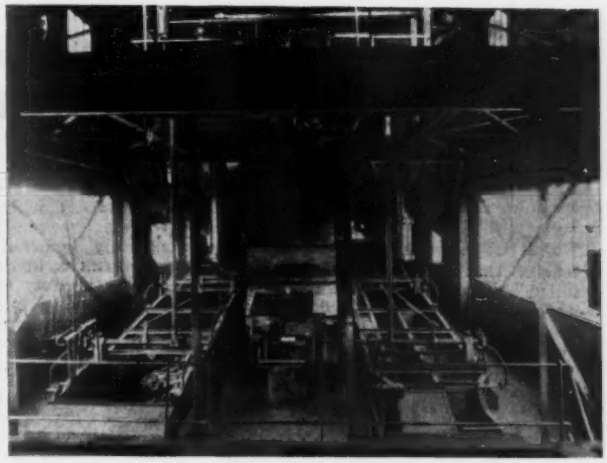
Material through the second box of the rewash launder is a bone, which is



Above and to the right are shown two views of the Carswell Tipple.

* Engineer in Charge of Preparation, Houston Collieries Company.





sent to the boiler house after the larger material is removed, crushed and returned to the main plant feed. An average of analyses shows this fuel to be 30 percent ash.

New underfeed stokers have been installed in the boiler plant and results have justified the decision to adopt this means of utilizing the bone products as fuel. Four of the six boilers now handle peak demands with ease. The wet crushed bone proves to be the best and most easily controlled fuel and is entirely acceptable to the boilers as at present equipped.

Washed coal over the ends of both the primary and secondary launders is sized into egg, stove and pea sizes and may be loaded separately as such or mixed with the picked lump and loaded as a washed run of mine.

Water and such fine coal as is carried with it, passing through the bottom deck of the washed coal sizing shakers and the fixed dewatering screens at the ends of the launders, is sluiced to a concrete settling tank, where the solid material is settled out and picked up by a dewatering bucket elevator, from which it is either loaded separately or sent to the power plant with the bone as fuel.

Overflow from the settling tank flows into the concrete pump sump adjacent to the settling tank, from which it is pumped to a constant head tank at the top of the washery building. As is customary, any make-up water required is added to the system in the form of fresh-water sprays on the washed coal sizing shakers.

It was considered inadvisable to provide the plant with a storage bin ahead of the main washing plant, as such provision, though desirable to obtain a uniform feed to the washing plant, would contribute largely to an excessive degradation of the very friable coal. Lack of this storage bin means that, as the mine car dump is intermittent, the plant operates at feeds fluctuating from zero to well over capacity. Centralized remote controls for the water cocks regulating the flow of water to the launders make it possible for one operator to adjust the plant quickly to follow feed fluctuations.

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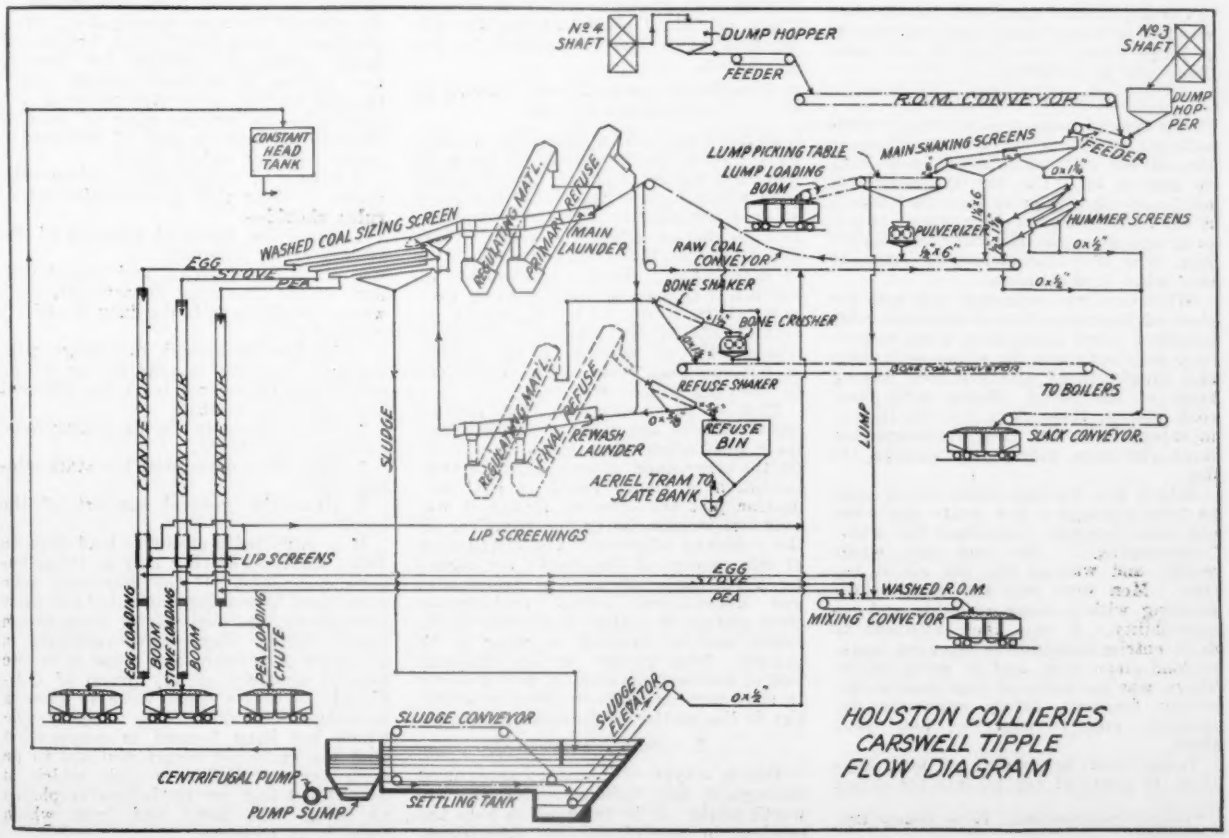


Methods employed in developing, maintaining and enforcing SAFETY CODES

By A. S. Wilson *

THE scope of this subject is so extensive that it will not permit much detailed discussion of any special methods. However, correspondence with a number of representative coal companies has developed a wealth of valuable information, and it is due to the splendid cooperation received from these companies that it has been possible to outline some of the various methods employed.

In any general discussion of methods used it must be remembered that we are to consider mining organizations ranging from, *first*, the large, financially sound concerns with a complete, well-organized safety department, including safety engineers, gas and mine inspectors, etc.; *second*, organizations of a type which, because of existing conditions, lack of funds or lack of safety appreciation, are obliged to carry on safety work in connection with their regular operating and engineering forces; and *third*, small companies, with practically no organization other than the force in charge at the mine. What is practical for one will not work with another; and it must, therefore, be left to your discretion to determine the methods most applicable to your particular organization.

DEVELOPMENT

Certain factors enter into the development of a safety code, and regulate, to a large extent, the type of the code. They are as follows:

1. *Labor Intelligence*

The type of men employed in any mine reflects in almost direct proportion to the success with which safety work may be carried on. The thrifty, intelligent man, seeking always to improve himself, is far more ready to cooperate in safety programs than the illiterate or shiftless man who does not know or seem to care what it is all about.

What have we today that will take the place of the old system of apprenticeship practised a few years back, when fathers took their sons into the mines with them and taught them practical coal mining right at the face? Along with their coal mining, these boys learned lessons in safety in a way that challenges the most elaborate safety organization today.

Where can we find today mines such as were common a few years ago when one mine foreman comprised the whole "organization"? He ran the whole works, and was on the job all of the time. Men went into the mine in the morning with a sense of pride and responsibility. It was their business to drive entries straight, to lay good track, to load clean coal, and to work safely. There was no force of face bosses, assistant foreman, safety engineers, inspectors, etc., to supervise and teach them.

Today, and by reason of law, boys 16 to 18 years of age go into the mines absolutely ignorant of their work and unappreciative of their responsibility. It becomes the duty of the operator, therefore, to develop in these boys an intelligent understanding of coal mining and safety practises.

2. *Labor Turnover*

In many sections of the country this is one of the greatest handicaps to a mining organization interested in safety work. It stands in the way of 100 percent first-aid training. It is extremely expensive in the amount of time required to teach new employes safety practises, and increases the safety hazard because of the frequency of "green" employes on the job.

Decreasing labor turnover presents much food for thought. It is generally recognized that increasing the morale of employes and making our mines and camps safer and cleaner places in which to work and live will return to us a group of better satisfied employes; and this, in turn, will serve to greatly decrease our labor turnover. It does not, however, reach the rover or the shiftless type.

3. *Whether Operation is Union or Nonunion*

These two distinct types of organization have developed two entirely different types of safety organizations, the differences of which are obvious to you gentlemen.

4. *Whether Compensation is Carried by Company or State*

In much the same manner that whether an organization is operating union or nonunion will react on the type of safety code which that organization will have, so does the manner in which compensation is carried affect the code. There are, of course, many arguments in favor of both plans. When compensation insurance is carried by the operating company there seems to be a greater incentive offered for making a thorough investigation of the cause of all injuries, to the end that those causes which can be removed will be removed.

Most of us appreciate that occupational injuries are a social problem, and their prevention is a humane activity. On the other hand, money spent for compensation is money spent in coal production just the same as though it was paid out in salaries or for supplies. If the company supervises the distribution of this money—if the checks are signed by a company official who appreciates and understands safety problems—a clear picture in dollars and cents of the actual cost of injuries is going to be gained. This picture is the financial side of accident prevention, and it seems to spur men on to more effective activities in the matter of decreasing injuries.

5. *Group Insurance*

This is a type of insurance much used throughout the industry, and appears worth while. It is designed to help the employe in case of sickness, nonoccupational accidents, and death. It does not seem desirable, by reason of cost, to have it cover occupational accidents—for these are already covered by compensation. It is interesting to note how many less compensible accidents occur when group insurance is in effect and has been designed to pay the employe about the same amount of money as compensation.

In addition, this type of insurance tends to eliminate begging by providing funds during the period of sickness, idleness because of nonoccupational accidents, and death. In many cases this insurance provided for burial funds, etc. With some companies it is optional; with others, compulsory. It costs from about $2 per month up, according to the policy carried.

6. *Mechanization*

The change from hand loading to mechanical loading, which is making such rapid strides throughout our country, will require changes in present safety rules. The details will have to be worked out as experience dictates, but it is certain that a rigid system of electrical inspection will be included therein. Mechanization is callying for closer and more intelligent supervision by foremen in charge; and operators will only pay for the use of that part of the body from the chin up—rather than from the chin down.

Study of the safety codes adopted by many representative companies shows that the several factors already mentioned have been considered by these companies in the development of their codes. And now to consider the codes themselves.

Investigation discloses that practically all of the larger companies have a set of safety rules. Many of them are printed in booklet form conforming to the style of the state mining law. Other companies have their rules printed on large cardboards suitable for framing and posting at various vantage points throughout the property, while a few companies follow the plan of making their safety rules a part of the organization of their safety clubs.

A review of these printed safety rules makes it clear that a successful set of rules should—

1. Have the financial support of the officers of the company.
2. Have the approval and honest support of the operating department, upon whose shoulders falls the duty of enforcing the rules.
3. Be flexible enough to change with changed working conditions, or to be modified as experience teaches a different and improved method.
4. Be pertinent to the particular mine or mines they cover.
5. Be in accordance with the state mining law.
6. Have the general support of the employes.

It is admittedly easier to lead than to drive, although driving may at times become necessary. If the employes have some part in making the rules for their own safety, the chances for cooperation appear better. Sane self-government is distinctly American, and since it is the natural tendency of any group of individuals to desire some voice in factors working for their interests, a safety code which has been formed in cooperation with the employes seems destined to be more successful than a code which is formulated and set up before employes as being "the law," and from which there is no recourse.

* General Superintendent, Boone County Coal Corporation.

One large company, operating in both union and nonunion fields, expresses the thought that any safety code should have for its aim the developing of a "safety sense" in the men, rather than the making of a set of iron-bound rules. This, they claim, can be accomplished through appealing to the natural bent of human beings toward cooperation, rather than to arouse the inherent antagonism of ironclad rules, which is a part of all human nature.

Summarizing the development of a code, it must be an evolution from a more or less crude beginning, through an experimental stage, and finally to a set of rules based on experience and which give due consideration to the various pertinent factors outlined above.

Throughout the experiences of all of the companies interviewed it was noted that the outstanding effort being made in developing a safety code is to get far enough under the skin of the employe to educate him to the point where he will desire and seek safety work. This matter of education is also the impelling force back of the second feature to be considered in connection with a safety code—that of *maintaining* the code.

Maintenance

To maintain a safety code requires the same constant, driving effort as is required to produce clean, lumpy coal, higher tonnages and lower costs; the details of which are familiar to us all. A superintendent, foreman, or face boss who forgets safety likewise neglects it. Safety is entwined with every act of coal mining, and it is the everlasting, day by day, thinking, talking, and—above all else—*living* safety that gets results.

Just as "a chain is no stronger than its weakest link," so a mine is no safer than its most reckless overseer. An official who sets a bad example by reckless driving of his automobile or by careless actions about his mine materially weakens any appeal he may make to his men on safety subjects or problems. Further, the official who permits his mine and equipment to get run down makes a "poor face" when going before his men on safety problems. In short, poor housekeeping breeds poor discipline. In making this statement, it is not intended that a mine must have all of the latest equipment. Good housekeeping demands that the plant be economically sound, and may mean the expenditure of very little money, but a very great amount of organization, coordination, and supervision.

The important question, therefore, is to maintain interest in safety. I know of nothing better than to enumerate some of the methods employed by representative companies to accomplish this end:

1. *Safety Suggestions*—An organized plan for receiving safety suggestions from employes is encouraged by some companies. In many instances when a suggestion made by an employe is put into use by the company, the man making the suggestion is given a cash prize. This is one method of bidding for the cooperation of the employes in developing safety rules, and while much of the material received by this plan is of little value, occasionally an idea will be gained which will be of sufficient worth to offset the many useless suggestions which are generally received.

2. *Bulletin Service*—The use of an illustrated bulletin service (such as is offered by the Elliott Service Company, National Safety Council, and others), with inspirational messages, pictures of current events and pertinent facts concerning accident prevention and kindred subjects, prepared in an attractive manner and posted in a conspicuous place about the mine, was recommended by several companies as being an excellent means of keeping the men interested in safety and putting them in touch with safety ideas. The pictures get them to the bulletin board, and the sale of a safety idea is made while they are there.

One company recommended the posting of a daily notice at the shaft or pit mouth carrying a safety thought or some comment pertinent to a recent injury at that particular mine. These, of course, would be "home-made" bulletins and could be made particularly applicable to the operation in question, if properly written.

3. *Safety Meetings*—Some companies make attendance at monthly or semimonthly safety meetings compulsory; with others it is optional. One company encourages attendance at the meetings by a scheme of drawing a "lucky number" at each meeting. Each employe is given a number when he enters the hall. Duplicate of this number is placed in a box, and at the close of the meeting a number is drawn from this box. The holder of the lucky number receives a cash prize. With some companies only employes are allowed to attend, while others invite those citizens of the community who are interested in safety work and community welfare. The value of these meetings lies in the opportunity that it gives the management for contact with the men, for discussing injuries with the men, and suggesting means for eliminating recurrences.

4. *Safety Police or Committee*—Some companies appoint among their employes safety police or safety committees. These appointments go to men who have had a good record with the company and who have manifested an interest in and an understanding of safety. It then becomes their duty to visit working places and observe violations of safety rules and to report the names of violaters to the proper authority. These violaters are then posted and they are either disciplined by the management or their cases taken up in a safety meeting or safety court.

5. *Safety Court*—The organization and working of a safety court is carried on, in a mock manner, of course, very much in accordance with the organization and procedure of our regular courts, with a judge, clerk, prosecuting attorney, attorney for the defense, etc. In certain organizations it has been found that the drama connected with the court proceedings, and the humor which sometimes develops, appeals to certain employes and teaches them safety lessons which they would learn through no other method.

The safety court and its workings was very ably described at last year's Congress, and you are no doubt thoroughly familiar with it.

6. *Monthly Bulletins*—The success of any safety code is measured by the results which it accomplishes in decreasing injuries and eliminating unsafe practices. As a measure of this progress, most all companies issue a monthly bulletin covering reports of the injuries at their properties, generally classifying them by causes and by occupation. These bulletins range from single, typewritten sheets, to more elaborately prepared printed booklets containing discussions of more serious accidents, editorials on safety, and pertinent facts concerning safety progress and the practises of other companies.

7. *Motion-Picture Films*—Many companies are taking up the use of the motion picture to illustrate and teach safety subjects, and are getting good results. Pictures depicting safety subjects will reach that type of men who can not, or will not, read the printed word or give heed to a talk on safety. That the use of motion pictures is of value is evidenced by the following story, which is quoted verbatim from a letter received:

"A man named Pritchard was one of the miners underground at the Spring Canyon mine in Utah at the time an explosion occurred, on March 6. Remembering the lesson portrayed in our picture entitled 'When a Man's a Miner,' he gathered four men about him in that particular section, explained the manner in which this picture showed miners in their predicament having built barricades to protect themselves against poisonous afterdamp. These five men were later rescued and, according to reports of the Bureau of Mines, they owe their lives to the lesson taught by our safety film and exercised by Pritchard, with the help of the four others."

8. *Monthly Inspections*—The inspection of mines with regard to safe working conditions serves a two-fold purpose: (1) It may develop a condition or practise in existence at the mine which is bad and which will be the cause of the formation of a new and important safety rule; and (2) it will make evident any failure to maintain or carry out rules already in effect.

The system of inspection is different with different companies, some having a force of several safety inspectors, gas inspectors, etc., while others do this work in connection with the engineering department. Some companies follow the plan of having the safety inspectors report their findings to the proper department (either the operating or the safety department), noting any infractions of rules and the names of the violaters, and their findings are taken up in safety meetings, safety courts, or with the foreman or employe responsible for the condition found.

9. *First-Aid Training*—Of all of the many methods suggested by the various companies for maintaining safety codes, the one idea of first-aid training was, with the exception of one or two of the smaller companies, universal—and it was the *only* method that was universal.

10. *Intercompany and State First-Aid Meets*—Tying right into the question of employes' first-aid training is the matter of holding intercompany and state first-aid meets where those taking the first-aid training can match their skill with other companies, and a spirit of rivalry fostered which will be reflected in the eagerness with which the work is carried on within each individual organization.

The splendid accomplishments along the line of state first-aid meets which have been brought about by the efforts of Mr. R. M. Lambie, chief of the West Virginia Department of Mines, and the results which they have had on lowering accident frequency in the State of West Virginia, are proof of the good results which are accomplished through this medium.

11. *Safety Certificate or Merit Badge*—At least one operators' association uses a system of reward to employes who work for 90 days without a blemish on their record, and whose work has the approval of the foreman. Such men are given a

card known as the "safety certificate," signed by the superintendent, as a sort of merit badge. This card is patterned after a lodge membership card. It is something for which the men work, and stands as a recommendation to them in the event of their leaving one company and seeking employment in the immediate vicinity.

This group of operators have within their association a wide-awake safety committee whose business it is to disseminate information to members. This information has to do with safe and unsafe employes, as well as new and better safety devices. A careless workman at one mine is refused a safe workman's certificate, as already explained, and it becomes difficult for him to get work within the district of the association. In other words, a careless workman becomes known, just as does a careful, safe workman.

Enforcement

The enforcement of a safety code is very closely allied to its maintenance; and in many cases the methods employed overlap.

Discipline of those who violate safety rules plays an important part in the enforcement of any safety code. It should be made plain to your employes that any discipline administered will be fair and impartial, and will be based on the facts as they are known to you. This discipline may be accomplished in a number of different ways:

1. Public posting of the names of violaters.
2. Reprimand by the management.
3. For repeated offenses, suspension for a period of time.
4. For continued violation, discharge.
5. Cash fines may be imposed by the management, safety meeting, or safety court, the money going into a fund to be used for welfare work in the community, under the direction of the safety club or similar organization.

Placing the responsibility for each injury at the proper place is one of the most important factors in carrying out any safety code. With our own company this is attempted by the following classifications:

(1) Violation of safety rules.—This places the responsibility on (a) either the employe who knew the rule and deliberately disobeying it, or (b) the foreman who failed to instruct his employe concerning the rule.

(2) Incident to the occupation.—This covers such cases as are caused by flying objects, sore hands, etc.

(3) Defective equipment.—An injury classed under this heading brings the responsibility to the door of the foreman who has not reported equipment on his territory which is in bad order; or the department which has failed to take care of any such defective equipment reported to them.

(4) Inadequate supervision. — This places the responsibility on the shoulders of the foreman in charge of the injured man. It is a classification under which no foreman likes to find himself charged, and it has, we believe, been a great factor in keeping our foremen on the alert in matters of safety supervision.

(5) Carelessness. — This classification should not be used if possible to avoid it. When an injury is so termed, it then becomes the duty of the operating department to give the employe proper instructions for doing his work.

(6) Questionable. — This classification is seldom used, but it may be resorted to when no other will fit. Any injuries which fall under this heading deserve a most thorough investigation and discussion.

The matter of requiring all employes to pass a physical examination before going to work is something which should work much good in favor of the operators, and will be a big factor both in the maintenance and enforcement of safety codes. This physical examination (1) eliminates those physically unfit for work; (2) gives the employer information concerning any existing disability or disease so that he may be protected from future claims for compensation on account of them. No operator who is a "square shooter" wants to shirk his responsibility to employes injured or maimed in his employment, but they do not choose to inherit the responsibilities of other operators.

With compensation rates always going up it seems necessary that ways and means should be made available whereby the "compensation hound" would be so labeled and known. All of you are familiar with his type.

Physical examination, group insurance, and the dissemination of information through operators' associations will all help to eliminate him. However, a program of education designed to awaken in men a safety sense and an appreciation of the fact that work pays better returns than compensation will undoubtedly be the ultimate remedy.

Summarizing, it appears necessary to:

(1) Know the policy of the company's officers toward safety work.

(2) Design rules which fit the labor available and the working conditions encountered.

(3) Adopt suitable methods for maintaining interest in safety work, follow these methods consistently, taking care to not let them become cut and dried.

(4) Enforce the rules by placing responsibility where it belongs and dealing out justice alike to all employes.

Cleaning Anthracite Coal

(*Continued from page* 81)

we don't use oversize mesh, the length has little or no real effect. Of course the trouble is with the "difficult grains" or those pieces which are nearly of the same diameter as the mesh, which will not fall through the holes.

I have installed shakers without pitch, with hangers inclined to the rear and have increased capacity per square foot per hour, and reduced the undersize, slightly, and reduced blinding of the mesh. These arrangements have helped results but I still feel that great improvements can be made.

In order to accomplish results and avoid dpulication of efforts ,it seems to me that there should be some central test laboratory where ideas could be developed for the use of all, or, our problems put up to those in charge for advice and investigation. I feel sure the general results attained through such a department would more than pay the cost.

No matter what may be accomplished in such a laboratory, we must all remember one thing, and that is, that automatic coal preparation is not here yet. Let it be one of our ambitions for the future, but for today, let us satisfy our critical trade with "Quality Anthracite" and educate them, so that they may appreciate the economies gained in using "Quality Combustible" which means lowering cost and greater efficiency.

Cleaning Coal at Carswell Plant

(*Continued from page* 83)

A recent test of all motors working in connection with the washery proper showed a power consumption of 1,227 kw. hrs. per ton of washed coal produced, of which 50 percent was used in water circulation. With the exception of the Hummer screens, this figure is exclusive of the original tipple machinery, but does include conveyors carrying the raw coal from the tipple building to the washery and the washed coal back to the tipple loading equipment. With the plant working at a higher capacity or less intermittently than when these tests were taken the above figures would be lower.

Under normal conditions the washing plant effects two separations, one at 1.5 specific gravity and one at 1.65 specific gravity. Material lighter than 1.5 is classed as coal and the heavier than 1.65 as refuse. The intermediate product is a steam fuel for the colliery power plant. Before the recent completion of the boiler plant everything lighter than 1.65 was classed as coal, and while the plant was working in this way tests showed a sink in 1.65 gravity liquid of 1.1 percent, 0.91 percent and 0.75 percent for the egg, stove and pea sizes, respectively. Float on the same gravity in the refuse was 4.1 percent.

The average sink in all sizes of washed coal was .88 percent, while the sink in the raw coal was 8.5 percent. Applying Dradeley's formulae, these figures give a qualitative efficiency of 90.6 percent, a quantitative efficiency of 99.7 percent, and a bank loss of 0.3 percent.

The benefits to the domestic market derived from such favorable preparation conditions is obvious. Where formerly we limited ourselves to following the practice common in the Pocahontas field of rejecting only such material as constituted really objectionable impurities, now, with the demand made upon us by the boiler plant, we are able to carry preparation to seemingly lavish extremes. The boiler demands approximately 80 tons of bone, or about 10 percent of the screen washed sizes. This mechanical rejection of bone explains the slight decrease in the recovery, but it is more than compensated for by the fact that the cleaned coal is a product assured of a market and is classed as a premium coal. It is consistently low in ash and a reduction of approximately 50 percent has been effected in the degradation at destination.

The efficiency of a washing plant can be derived by formulae and expressed in figures, but its true measure of success is whether or not its product can be marketed. Before the installation of the cleaning plant, considerable sales resistance was encountered with Carswell coal. Since the washer plant has been operating, sales resistance is almost negligible.

The Houston Collieries Company feels that their Carswell mine as it is now equipped is one of the most modernized properties in the Pocahontas field.

The relation of Mechanical Mining . . . to Safety

By A. W. Dickinson *

WE, of the coal industry, consider the term "Mechanical Mining" to cover the performance of the work of face preparation, loading, hauling, dumping, conveying, cleaning, and sizing through the agency of mechanical devices. In the present era of civilization the use of the rope and windlas for hoisting and hauling was probably the first application of mechanical power in mining. Engines driven by steam followed in the application of power to hoisting, haulage, pumping, and fan driving. The next advance came with the introduction of compressed air for haulage, pumping, drilling, and undermining coal. From 30 to 40 years ago electrical power entered the mines as the propelling agency for locomotives, pumps, and coal-cutting machines, and many of the men identified with coal mining today have witnessed the evolution of these devices into the useful tools of the present.

There is no doubt that many men thought of the loading machine a long time ago, but such a device for use in the close confines of underground coal mining did not take form until about 25 years back. Vision and courage were needed at that time to foresee commercial success for a coal-loading machine. Labor was plentiful and cheap, and the transmission and use of electrical power in coal mines was still in its infancy. As the use of power for haulage and cutting grew, the war years came, and in 1916 coal prices in the market jumped to unprecedented heights, a status which continued until 1921. High-cost fuel drove the railroads, the public utilities, and the other large consumers of coal to the most rigid programs of fuel economy, with the result that until 1929 a distinct check has been felt in the demand for coal. The pressure for cheap fuel resulted in a state of the market such that hundreds of high-cost operations were taken out of production and the mines abandoned.

Hard pressed for means to reduce the cost of production, the thoughts of operating men turned to the use of power and machines to replace the uneconomic and wasteful loading of coal by means of hand shovels. With this power application to the last of the hand processes, mechanical mining was originated in fact. While the tonnage of coal loaded with machines is but a small part of the total production, it is well for several reasons that mechanical loading is receiving attention. At present the supply of labor is thought to be sufficient, and we do not regard our reduced immigration as an influence in coal mining. There is now a proposal that all immigration from western and eastern hemispheres alike be stopped for five years. The new generation of underground workers in coal mines care less and less to load coal with a hand shovel. Regardless of occasional hesitations (largely seasonal) in the progress of trade, our country is forging ahead in the world's markets and manufacturing is inevitably on the increase. The production of coal increased in 1929 over that of 1928, and the year 1930 will show additional increases.

The trend of the industry points toward an increasing tonnage loaded by machines:

First. Because more coal can be loaded per man.

Second. Because men in this day do not take up the work of loading coal with a hand shovel from choice or preference.

There is still another reason which makes for a preference for mechanical mining, properly conducted, and that is the increasing conviction that it is accompanied by less killing and maiming of men. This statement must needs be guarded by the words PROPERLY CONDUCTED.

Be it known and realized that in introducing locomotives, cutting machines, loading machines, drills, fans, pumps, and involved wiring systems that the mines first of all must be guarded from ignitions of gas and dust and from the setting of fires thereby.

Now the full and proper ventilating of coal mines is by no means a new thing to the industry. The means at hand for accomplishing the adequate ventilating of mine faces and passages today surpass anything ever known in the history of the art. With the multiplying by many times of the possible sources of ignition of gas and dust it is imperative that nothing in the ventilating scheme of a coal mine shall be left to the mercy of chance or human error. In this connection it is well to consider the provision of additional airshafts when the active workings of mines have progressed to such distances from the main openings or portals that the water gauge of the ventilating circuit mounts and ventilation becomes more difficult. Material economies which amply repay the cost of such shafts are generally found to be the rule. A gratifying reduction in the cost of power to supply ventilation follows the reduction in water gauge occasioned by the placement of relief airshafts near the active working faces.

In mines where the employment of cutting, drilling, and loading machines has been developed to a useful degree, the faces in both narrow and wide work advance at rates of progress hitherto unknown, and until the upkeep of the ventilation detail is synchronized with such rapid advance, extreme caution is necessary in proceeding with so much freshly opened coal face. Double and triple shifting on this work adds to the area of freshly opened face bared per 24 hours.

The methods of neutralizing coal dust and of keeping its presence in mine atmosphere to a minimum are well known. But their employment is extremely important to the safe conduct of the modern mining operation.

In modern mechanical mining the ragged, dangerous placement and maintenance of electrical wiring must cease for the excellent reason that there is no place for such procedure, and the hazards that it involves in an operation requiring a positive power supply and where workmen are concentrated in a comparatively small territory. Proper junction boxes must replace the obsolete "nip" connections, and all wiring from the main feeders must be in flexible conduit to the point where the service cables are connected. Grounding and protective devices must be made positive on cutting, loading, and drilling machines. These statements are made and these warnings sounded in the earnest desire to call attention to and avoid the dangers of catastrophe in connection with our modern mining.

Now in the full knowledge that the hazards of additional equipment are to be considered and met by the exercise of good mining practice, we may inquire as to the cause for the growing conviction that mechanical mining is accompanied by less killing and maiming of men. The answer is that operating men, with few exceptions, know from the records of performance of their own mines that operating under mechanical mining they are suffering a lesser number of injuries to their personnel. As the result of the decrease in injuries, there has been a material reduction in the cost burden of this phase of the operating problem. In some instances responsible men in the coal industry have stated that injuries have been reduced 50 percent and more. If, for the 600,000,000 and more tons of anthracite and bituminous coal mined, a cent a ton can be cut from the compensation bill, remember that it means $6,000,000 to help what has been designated as our "worst functioning industry." It is not thought that the operating men of the coal industry realize the magnitude of the annual compensation bill. Mechanical mining, properly conducted, holds forth a gratifying return in this humane and worth-while phase.

The reduction in accidents under mechanical mining is particularly marked by a smaller number of what have been designated as the "sniping" injuries; a man picked off here and another over there. These fatalities and injuries quietly, persistently, and relentlessly occurring over the mining fields of the United States do not attract notice. They are not spectacular, but their total has been and is appalling. The "sniping" accidents pounce upon the men at or near the working faces of narrow and wide work. Under mechanical mining the number of men exposed for the production of a given quantity of coal is materially reduced. The same fact holds true for the area of territory from which the coal is taken day by day. It is then axiomatic that, under proper conduct and supervision in mechanical mining operations, a lesser number of men will be injured.

There is another important factor which enters into the subject of the Relation of Mechanical Mining to Safety, a factor which up to the present time has not been under analysis by the industry at large. Reference is made to the basis upon which workmen are employed in the preparing, loading, and hauling of the coal from the face out to the surface. Speaking broadly, it is considered that there are two methods of employment; that is (1) day work, (2) contract.

When all of the functions of mechani-

* Mining engineer, the American Mining Congress.

cal mining are performed on a day work basis under a high and efficient degree of supervision with the foremost thought given to the protection of the workmen from injury, the production of coal is accompanied by the minimum in injuries suffered by the workmen.

When a mine is equipped for mechanical mining and the workmen are employed to use the devices for preparing, loading, and hauling the coal on a contract or similar basis, they may be successful in holding down their injuries, but it is not found in the experience of the industry in the various fields of the country that they actually do so. The very human inclination to risks again enters the problem and battle as the supervisory men will to safeguard the work, there remains the temptation before the workman to turn momentary risk into pecuniary gain, and the history and experience of the old contract loading days are repeated.

Operating men do not agree with regard to the matter just recited. Some say that if workmen are not placed upon a contract basis they will not perform and that the matter of safety at the face rests with the individual. Others speak of instances where the men working on a contract basis, with the attention of supervisory officials turned elsewhere, were prone to develop unsafe practices in their daily work in their effort to increase revenue production.

There is still another thought in connection with mechanical mining and its relation to the safety of the workmen. The loading machines and the methods of their employment are quite new. In the past three years we have started a movement which amounts to a revolution in an industry which has followed the lines of least resistance for over 700 years of record. The plain truth is that: That we can only surmise what the performance of the new mechanical mining will be next year and the year after.

We do know that in 1929 and early in 1930 performance records of the past have been broken on face preparation and loading. This will be done again. Is it time to fix task bases and contract rates before we know what the machines are worth to operator and workmen? And in the fullest attempt to guard the safety of the workmen should those charged with the management of coal properties surrender in the slightest degree the responsibility of management at the face? The entire matter merits careful study on the part of all, and the men who are familiar with the wage scales and safety work of the past 20 and 30 years can render valuable aid.

DISCUSSION

The Relation of Mechanical Mining to Safety

S. W. Blakslee, *general manager, Pennsylvania Coal and Coke Corporation:*

My remarks deal principally with the mechanical loading angle of the mechanical mining game.

The following figures are taken from the history of our company for a period running from July 1, 1924, at which time we introduced mechanical loading into our mines, to March 31, 1930. In this period we produced 13,359,132 tons of coal from seams ranging in height from 31 to 48 in. Of this tonnage, 2,487,120 tons were produced by scraper loaders and conveyors and no fatalities were incurred that were chargeable against this form of mining. During the mining of the remaining tonnage of 10,872,012 tons which were loaded by pick and machine miners there were 16 fatalities at the working faces caused by falls of coal and rock, or for every fatality at the working face there were produced 906,001 tons of pick and machine coal.

Inasmuch as we had a potential fatality, a broken back, after having mined 2,362,570 tons, a comparison of fatalities from the different methods of mining show one fatality for every 2,362,570 tons of mechanically mined coal against 906,001 tons of pick and machine coal.

In 1928 we began to keep separately a record of accidents caused by scraper and conveyor loading. It shows that from January 1, 1928 to March 31, 1930, that while mining 1,563,225 tons of mechanically loaded coal we had 226 accidents chargeable against scrapers and conveyors or one accident for every 6,916 tons of mechanically mined coal. Of these accidents 160 were non-compensable and 66 were compensable. The total number of days lost were 2,995, or 13 days per accident.

Nineteen hundred and twenty-nine was our banner safety year. We had but two fatalities for the 2,400,000 tons mined, and the percentage of mechanical loaded coal mined reached its highest point to date—34%.

We are thoroughly convinced that mechanical loading is the safer method of loading coal.

Safety in Mechanical Mining as Compared with that of Hand or Contract Mining

Edward Bottomley, *general superintendent, Sheridan-Wyoming Coal Company, Kleenburn, Wyo.:*

There are hazards connected with mechanical mining that are not encountered in hand work, and I believe Mr. Dan Harrington, Chief of the Safety Division of the Bureau of Mines, was right when he issued warning to that effect, but from my own personal experience it would seem to me that outside of the actual work of loading coal at the face, there is little or no difference in the hazard of the two methods unless the introduction of machines has brought about radical changes in the system of mining employed.

As to the Sheridan-Wyoming District in which my experience on the matter of mechanical mining is based, no radical change was made in our system of mining when loading machines were introduced, and our greatest and only added hazard as a result of mechanical mining was the fact that the noise from the machines precluded any probability that the loading machine crew would be warned in advance of a fall of roof or coal before the fall actually occurred. That danger has been overcome by very close inspection and removal of all dangerous conditions as far as possible before a machine crew enters a place to load coal, and we have also built on our power shovels, for the protection of the operator who because of the position in which he works has slight chance, if any, of escape in case of a large fall of roof or coal, a well-constructed safety hood. These two precautions in themselves have largely overcome the danger to our men from falling roof or coal.

In hand or contract mining the great percentage of accidents, notwithstanding the fact that the men are not handicapped by any noise from loading machinery, usually occur from fall of roof or coal, and as the result of carelessness on the part of the miner himself, who in his haste to get his car loaded, and more especially in the morning, often neglects to make the proper inspection of his working place to replace props that have been knocked out by shots fired the previous night, which sort of reckless haste on the part of the average miner has, to my personal knowledge, resulted in many serious accidents.

So far as our company is concerned, the precautions taken in connection with mechanized mining to protect loading machine crews from falls of roof or coal have resulted in the entire elimination of that particular type of accident which I have referred to in the preceding paragraph, our accident record being conclusive proof of that statement.

Pittsburgh Coal Company—Accidents with Hand and Mechanized Loading

C. A. McDowell, *safety and personnel manager, and* **J. T. Clark,** *superintendent of Banning No. 2 Mine, Pittsburgh Coal Company:*

The Pittsburgh Coal Company has completed two years of experience in mechanized mining in Banning No. 2 Mine, and in that period 56.8 percent of the total production was produced mechanically; 41.3 percent produced in 1928 and 68.9 percent in 1929.

Joy loading machines and pit-car loaders are used in the mehanical operations of this mine. There has been no change in the system of mining as reported in the proceedings of 1929. This system requires close supervision and systematic and efficient timbering for safe operation.

The record of accidents chargeable to mechanical loading (which includes pit-car loaders) and hand loading is based on those that occur from the parting to the face, and includes all lost-time accidents (beyond the day of shift) to all occupational employes in these respective sections. Lost time for deaths and permanent disabilities is computed from a table used by the United States Bureau of Labor Statistics and different industries of the country for comparisons. This basis of comparison is thought just and sets up a definite number of days lost for deaths and permanent disabilities.

In the two-year period no fatalities occurred chargeable to mechanical loading, but there were two serious accidents, one causing amputation of four complete fingers, and one causing partial amputa-

ACCIDENT DATA, BANNING NO. 2 MINE, PITTSBURGH COAL COMPANY

	1928—Mechanical				1929—Mechanical			
	Loading Machines	Pit Car Loaders	Total	Hand Loading	Loading Machines	Pit Car Loaders	Total	Hand Loading
Tons produced	227,776	.....	227,776	324,104	409,906	74,262	484,168	218,224
Number of accidents	3	.....	3	88	18	12	30	69
Number of days lost	38	.....	38	1,226	*2,128	208	*2,336	†7,853
Days lost per accident	4.8	.....	4.8	13.9	118.2	17.3	77.9	113.8
Tons per accident	28,472	.....	28,472	3,683	22,773	6,189	16,139	3,162
Percent total tonnage loaded	41.3	.....	41.3	58.7	58.4	10.5	68.9	31.1
Frequency rate (number lost-time accidents per million hours worked)	45.2	.....	45.2	200.9	37.7	266.6	57.6	202.1
Severity rate (days lost per thousand hours worked)	.27	.....	.27	2.8	4.4	4.6	4.5	23.1
Tonnage rate (days lost per thousand tons produced)	.17	.....	.17	3.8	5.2	2.8	4.8	36.0

* 1 accident loss of 4 fingers, and 1 accident loss of partial finger.
† 1 fatal and 1 accident loss of finger.

ACCIDENT DATA, BANNING NO. 2 MINE, FIRST THREE MONTHS OF 1930

	Mechanical			
	Loading Machines	Pit Car Loaders	Total	Hand Loading
Number of accidents	.....	4	4	1
Number of days lost	.....	166	166	3
Days lost per accident	.....	41.5	41.5	3.0
Tons produced	66,583	28,023	94,606	32,837
Tons per accident	.....	7,006	23,652	32,837
Percent total tonnage loaded	52.2	22.0	74.2	25.8
Frequency rate	.....	153.5	46.3	19.0
Severity rate	.....	10.5	1.9	.06
Tonnage rate	.....	5.9	1.8	.09

tion of one finger, both of which occurred in 1929. No fatalities or serious accidents were chargeable to hand loading in 1928, but in 1929 there was one fatality and one accident causing the loss of a complete finger.

The data for 1928 and 1929 are shown in the tabulation at the top of this page.

In the two years of experience at this one operation we have produced 442 percent more tons per accident by mechanical methods than by hand, but a more accurate comparison would be the fact that this method shows 406 percent less days lost per 1,000 tons produced than in hand loading. The severity rate (days lost per 1,000 hours worked) shows 244 percent in favor of mechanical loading, and the frequency rate (number of lost-time accidents per 1,000,000 hours worked) shows 271 percent in favor of mechanical loading.

Pit-car loaders were introduced in this mine in June, 1929 and reached peak production in August, 1929, and are included under mechanical loading. Many accidents occurred under pit-car loading sections which could be properly classed under hand loading, inasmuch as the preparation of a cut of coal for the operation of a pit-car loader, the removal of same, and the posting of roof and draw-slate must be carried out similar to hand loading.

In other words, many accidents chargeable to pit-car loading, especially from falls of roof, would, no doubt, occur with the same conditions under hand loading.

For the first three months of 1930 the data for Banning No. 2 Mine are available as shown in the above table.

No accidents are chargeable to loading machine sections in the above period, and this mine has worked 52 days to March 31 in this year without a lost-time accident on loading machine sections. Production was 127,500 tons, of which loading machines are credited with 52 percent. However, mechanical mining (including pit-car loaders) produced 74 percent of the total tonnage. The severity rate (days lost per 1,000 hours worked) for the entire mine is but .7 for the above period.

Over a period of two years and three months to April 1, 1930, we show a production of 1,301,384 tons produced by mechanical loading machines (exclusive of pit-car loaders) without a fatality, and this compares with 887,702 tons for fatality by hand loading in the same mines. A fair comparison, however, would be based on days lost per 1,000 tons produced, and we find 235 percent less days lost in favor of mechanical loading.

By including pit-car loading under mechanical mining for all mines operating pit-car loaders, we have a production of 586,706 tons per fatality, as compared with 506,801 tons per fatality hand loading. At the same mines we have 76 percent less days lost in favor of mechanical loading.

In developing the mechanical mining program we are finding a most helpful cooperative spirit among officials and employes. They indeed appreciate the fact that mechanization has come to stay and are most willing to learn all they can about it. It is this spirit of confidence and cooperation that has brought about a reduction of accidents in this new method of operation over hand loading.

Accident Statistics in the 100 Percent Conveyor-Operated Mines of the Superior Coal Company

F. S. Pfahler, *vice president and general manager, Superior Coal Company:*

There are many angles of a safety campaign and a method of procedure which exactly fits one operation will not suit another. Neither is it always proper to compare the accidents at one mine to those of another, because of the differences in natural conditions, equipment, management or personnel. Of course, it is possible to change or educate, but the condition of the coal seam and the overburden are always with us. There are times when the overburden is apparently too safe in that there is a false security or a contempt is bred in the minds of both management and employes for conditions that do not seem to exist.

A reduction in accidents should be a reduction at each particular plant without regard to a general average of several plants and a commendable record at one plant should be far from acceptable at another mine.

The Superior Coal Company's Mines 1, 2, 3 and 4 were all operated on a hand loading basis previous to 1928, and the natural conditions were not as favorable to the prevention of accidents at Mines 1 and 4. It was at these two mines that conveyors or pit-car loaders were established on 100 percent basis during the year 1928.

For the purpose of comparing the accident rate at Mines 1 and 4 under the pit-car loading system, I have made up two charts. The comparison is between the years 1923 to 1927, inclusive, which were on the hand loading basis with the year 1929, which was on the conveyor basis. A separate comparison is made for each mine. The results of accidents prevention for the year 1928 are not shown for the reason that conveyors were installed during that year but the figures for that year do show a substantial saving in accidents after the installation of the conveyors. I made a report before the Congress last year on the 1928 results.

MINE NO. 4

	Years 1923 to 1927, inclusive	Year 1929
Tons produced	5,277,549	1,050,000
Total hours worked by all employes	7,086,224	1,093,502
Fatalities	10	1
Permanent total disabilities	1	0
Permanent partial disabilities	133	19
Compensable injuries	729	115
Non-compensable injuries	688	63
Total injuries	1,417	178
Days lost account injuries	26,468	3,756
Tons produced per accident	3,724	5,899
Accidents per 1,000,000 hrs. worked	200	163
Days lost account injuries, per 1,000 hours worked	3.74	3.43

MINE No. 1

	Years 1923 to 1927 inclusive	Year 1929
Tons produced	4,348,044	736,797
Total hours worked by all employes	6,368,208	776,312
Fatalities	1	.....
Permanent total disabilities	.....	.....
Permanent partial disabilities	100	15
Compensable injuries	603	48
Non-compensable injuries	480	54
Total injuries	1,083	102
Days lost by injuries	18,783	1,966
Tons produced per accident	4,015	7,223
Accidents per one million hours worked	170	131
Days lost account injuries per 1,000 hours worked	2.95	2.53

The gains under the conveyor system of loading are 3,208 tons of coal more produced per accident. 39 fewer accidents per million hours worked, and .42 less shifts of work lost on account of injuries per 1,000 hours worked. I might point out to you that Mine No. 1 has had but one fatality since March 11, 1922, and in this period of time has produced 6,210,591 tons. These figures up to April 19, 1930.

The results at Mine No. 4 since conveyors were installed show a gain of 2,175 tons per accident and 37 fewer accidents per one million hours worked and .31 less shifts of work lost per 1,000 hours worked because of injuries. We have had one fatality at Mine No 4 since the establishment of conveyors. This occurred on the haulage and was on no way related to the changed system of mining.

COMPARISON AT JEROME MINE BETWEEN PICK AND MACHINE MINING AND MINING ON CONVEYOR BASIS

OPERATION ON PICK AND MACHINE MINING BASIS

	1921	1922	1923	1924	1925	Total
Total net tons produced	601,972	381,389	437,353	464,061	698,742	2,583,517
Total accidents	172	129(2)	169(1)	146	118	734(3)
Tons mined per accident	3,500	2,956	2,588	3,178	5,921	3,520

OPERATION ON CONVEYOR BASIS

	1926	1927	1928	1929	Total
Number of conveyors working	3	9	18	22	22
Total net tons produced	30,000	106,000	181,000	233,798	550,798
Total accidents	1	1	14	6(1)	22(1)
Tons mined per accident	30,000	106,000	12,929	38,966	25,036

TOTAL NET TONS PRODUCED BY PICK AND MACHINE MINING AND CONVEYORS—TOTAL ACCIDENTS ON PICK AND MACHINE MINING AND CONVEYORS—TONS MINED PER ACCIDENT

	1926	1927	1928	1929	Total
Total net tons produced	704,773	803,050	901,286	854,149	3,263,258
Total accidents	84(3)	74(1)	181(3)	139(6)	478(13)
Tons mined per accident	8,390	10,852	4,980	6,145	6,826

NOTE—Figures in parentheses indicate number of fatal accidents. For example, there were 129 accidents in year 1922. In this total of 129 is included 2 fatal accidents.

In all cases when figuring tons mined per accident, non-fatal accidents only are considered in arriving at these totals. For example, in year 1929 there was a total of all accidents amounting to 139—6 fatal and 133 non-fatal.

Accident Experience Before and After the Introduction of Conveyors at the Jerome Mine of the Hillman Coal & Coke Company

A. E. Siemon, *division general superintendent, Hillman Coal & Coke Company:*

As the title implies, I shall base my statements on the experience of the Hillman Coal and Coke Company at Jerome Mine, located at Jerome, Somerset County, Pa.

The mine is working the C Prime, or Upper Kittanning, Seam, of a thickness varying from 32 in. in some sections to 60 in. in others. The roof conditions are good in some parts of the mine and bad in others, and a 10 percent pitch of seam encountered in parts of the mine makes for dangerous haulage conditions.

Mention of accidents in connection with mechanical loading refers only to conveyors, as no other type of mechanical loader is in use.

The figures given cover a period of five years prior to the installation of conveyors (1921 to 1925, inclusive), and four years after the installation of conveyors (1926 to 1929, inclusive).

In 1921 the production was 601,972 tons, the total number of accidents 172, and the production per accident 3,500 tons.

In 1922 the production was 381,389 tons, the total number of accidents 129, and the production per accident 2,956 tons.

In 1923 the production was 437,353 tons, the total number of accidents 169, and the production per acident 2,588 tons.

The year 1924 shows some improvement over 1923: The production was 464,061 tons, the total number of accidents 146, and the production per accident 3,178 tons.

Further improvement was made in 1925: The production was 698,742 tons, the total number of accidents 118, and the production per accident 5,921 tons.

The total production for the five years was 2,583,517 tons, the total number of accidents 734, and the production per accident 3,520 tons.

The first conveyor was installed in 1926 and by the end of the year three conveyors were in use. The production by conveyors was 30,000 tons, with but one accident chargeable to conveyors. The total production of the mine for 1926 was 704,773 tons, the total number of accidents 84, and the production per accident 8,390 tons.

By the end of 1927 the number of conveyors in operation had increased to nine, and the production was 106,000 tons, with but one accident chargeable to conveyors. The total production of the mine for 1927 was 803,050 tons, the total number of accidents 74, and the production per accident 10,852 tons.

By the end of 1928 the number of conveyors in operation had increased to 18, the total production was 181,000 tons, the total number of accidents 14, and the production per accident 12,929 tons. The total production of the mine for 1928 was 901,286 tons, the total number of accidents 181, and the production per accident 4,980 tons.

The end of 1929 saw 22 conveyors in use, the production was 233,798, the total number of accidents 6, and the production per accident 38,966 tons. The total production of the mine for 1929 was 854,149 tons, the total number of accidents 139, and the production per accident 6,145 tons.

For the four years 1926 to 1929, inclusive, the production by conveyors was 550,798 tons, the total number of accidents 22, and the production per accident 25,036 tons. The total production of the mine for the four years 1926 to 1929, inclusive, was 3,263,258 tons, the total number of accidents 478, and the production per accident 6,826 tons, as compared to 3,520 tons per accident for the years 1921 to 1925, inclusive, or prior to the introduction of conveyors.

The company's policy is to report all accidents, and the figures include minor, major and fatal accidents.

While I do not attribute the reduction in accidents entirely to conveyors, I am certain they are partly responsible for the reduction, principally because the work is more concentrated and permits of closer supervision. Also, on account of rapid extraction, roof action is entirely different and less hazardous than was the old hand-mining methods. Conveyors have also prevented accidents by reason of the elimination of car handling by the men, especially where there are steep grades.

The successful operation of any type of mechanical loading depends largely upon the type of man employed, and, naturally, we try to employ the more intelligent man for conveyor work. We are not always successful in doing this, but, generally, I believe the men working on conveyors have a higher degree of intelligence than the average hand loader, which, no doubt, reflects in the large production per accident in conveyor mining.

Frank Hillman, *chief mine inspector, Woodward Iron Company:*

This paper deals with accident prevention where mechanical loading equipment was used in the Mulga coal mine of the Woodward Iron Company, and is for the calendar year 1929.

Mechanical loading was started in 1928 and increased in 1929. The coal bed worked is the Pratt seam, and where mechanical loading equipment is in use the seam mined averages 31 in. high, with a roof from good to bad. Two types of equipment are used—the scraper loader and the chain conveyor. Where the scraper loader is used, rooms are driven in 250 ft. at an average width of 12 ft., then widened V-shape from each side to 100 ft. with a wall face of 120 ft. to each side. The coal is undercut to a depth of 6 ft. with a short-wall electric-driven mining machine. Permissible explosives are used and shots are fired electrically. In some places there is a draw slate over the coal that ranges from 2 to 10 in. in thickness, and again there are rolls or horse-backs at frequent intervals; many of them have a thin coal streak between them and the natural roof; others have a smooth slip with no cleavage. The nature of the roof requires props set 2½ ft. apart and within 4 ft. of the coal after it is cut. As the scraper loader cleans up the face, props are set to prevent the roof having too large a swing.

Where conveyors are used, coal was first mined on the room and pillar system. They were driven in 260 ft. deep and 70 ft. wide. During this time portable belt conveyors 20 ft. long were used to deliver the coal onto the main conveyor—shifting of the belts to the face to load each fall of coal. The roof was so bad that props were set within 2½ ft. of the face before the coal was shot down, and as the loose coal was loaded props were set between the belt and the face, and after the face was cleaned up and the machine started to undercut a timberman followed the machine setting props. Later in the year the system of

loading the conveyors was changed. A room 15 ft. wide and 260 ft. deep is driven, then rooms are turned on 40-ft. centers and driven in 260 ft., with a width of 30 ft. Coal is brought from the face and loaded onto the conveyor with scraper using a double drum hoist. By this system of mining there was an improvement in safety conditions, as props could be set closer to the face without having to be taken out, as was the case with the face belts. The width of the runway for the scraper is 8 ft. Crosscuts are cut every 60 ft., and water used on the cutter bar of all mining machines. All places are kept rock-dusted to the face and samples of rock-dust are taken each month and analyzed. Air readings and air samples are taken and analyzed each week.

All men working around the mechanical equipment are required to wear goggles; this has reduced the eye injuries to a minimum, and has not increased other class of injuries. Each room is worked as a separate unit with a shift leader, who has charge and is held responsible for the men working under him. In addition, there is a foreman who has charge of mechanical loading.

There were 10 lost-time accidents for the year 1929 in mechanical loading territory, with a frequency rate of .057 per 1,000 man-hours worked, with a severity rate of 1.27 hours per 1,000 hours worked.

Marion County Coal Company

Jno. W. Stedelin, *vice president Marion County Coal Company:*

A comparison of the personal injury record at the Glenridge mine of the Marion County Coal Company shows an improvement in 1929 over the 1928 record. This we attribute to a closer supervision and better education both of the official family and the men. Following is a comparative record for the years 1928 and 1929:

	1928	1929
Coal produced	336,156	363,900
Number days worked	241	189
Number man days	41,250	42,928
Number of personal injuries	129	108
Injuries at coal face	49	43
Tons produced per face accident	7,268	8,463

One permanent injury and no fatal accidents in 1929.

No permanent injuries nor fatal accidents in 1928.

Of the total number injured there were 52 reported with no time lost.

Experience of the Allegheny River Mining Company

Edgar W. Tait, *president, Allegheny River Mining Co.:*

The method of mechanical loading we are using is by scraper loaders with long wall V panels, but not operating the two concave sides of the V at the same time. Rather we work our scrapers in pairs, each one in a separate adjoining panel, and alternating the loading with the cutting and scraping so as to eliminate time lost by reason of shooting, etc. We also drive our narrow places with scraper loaders.

In 1929 out of our total output 44 percent was loaded by mechanical means. We had three fatal accidents, none of which had any connection with mechanical loading on long faces.

Of the non-fatal accidents, our experience per 100,000 tons of production was as follows:

Mechanical loading, 13 1/10th accidents; hand loading, 14 7/10ths accidents; days lost from mechanical loading accidents, 400; days lost from hand-loading accidents, 467.

Per 100,000 tons of production we had 4 3/10ths accidents directly due to hazards peculiar to mechanical loading; these accidents caused 87 lost days per 100,000 tons of mechanically loaded coal.

Of the non-fatal accidents caused by hazards common to both hand and mechanical loading there were 313 lost days per 100,000 tons caused by accidents to men engaged in mechanical loading and 467 lost days caused by accidents to men engaged in hand loading.

In conclusion, mechanical loading has not been the cause of any of our fatal accidents. Of the non-fatal accidents there were slightly fewer accidents to men engaged in mechanical loading, and the number of days lost was distinctly in favor of mechanical loading. The accidents caused by hazards peculiar to mechanical loading were comparatively few and of comparatively little seriousness. Of the non-fatal accidents caused by hazards common to both hand and mechanical loading, the experience was quite distinctly in favor of mechanical loading.

In general, our experience in 1929 corroborates the opinion we had formed in 1928 that there should be fewer accidents with mechanical loading than with hand loading. The reason for this is, I believe, the better opportunity for supervision and the better class of labor employed in mechanical loading.

The Consolidated Coal Company of St. Louis

W. J. Jenkins, *President and General Manager.*

While our mine No. 15 has only been completely mechanized since September 14, 1929, and we have had only seven months actual operation, in so far as statistics in regard to accidents are concerned, we do have a "deadly" comparison, because during the six months of its operation we operate mine No. 7, Staunton, partly with conveyor loaders and partly hand loading.

For the seven months ending March 31, 1930, mine No. 15, with full mechanical loading (Joys) produced 474,166 tons of coal. We experienced 78 accidents, with total number of days lost to March 31, 799. Average number of days lost per accident, 10.2. Ten men injured during the month of March were reported as still idle on March 31; all other employes injured prior to March 1 had returned to work.

At mine No. 7, during the period September 1, 1929, to February 28, 1930,

(*Continued on page* 103)

Number of Lost Time, Accidents and Tons of Coal Mined at Collieries of Pocahontas Fuel Company, Inc.

Presented by **A. V. Sproles,** *safety director, Pocahontas Fuel Company, Inc.*

Classified as to Hand Mining and Machine Mining, for year 1929, *and for four years beginning January* 1, 1926, *and ending December* 31, 1929.

Colliery	Lost-time accidents year 1929	Lost-time accidents 4 years	Tonnage 1929	Tonnage 4 years	Tons mined per lost-time accident, 1929	Tons mined per lost-time accident, 4 yrs.
POCAHONTAS:						
Hand mining	148	660	474,524	1,737,470	3,207	2,632
Machine mining	79	162	325,646	1,183,570	4,122	7,306
BOISSEVAIN:						
Hand mining	22	240	227,026	761,594	10,319	3,173
Machine mining	37	149	349,324	1,272,606	9,500	8,541
CASWELL CREEK:						
Hand mining	40	132	165,700	657,800	4,142	4,984
SAGAMORE:						
Hand mining	42	162	338,200	1,270,980	8,052	7,845
NORFOLK:						
Hand mining	5	50	116,303	440,912	23,260	8,818
Machine mining	8	17	64,377	238,398	8,047	14,023
ANGLE:						
Hand mining	25	106	254,260	933,680	10,170	8,808
SHAMOKIN:						
Hand mining	14	76	126,987	343,956	9,070	4,526
Machine mining	36	87	231,513	954,844	6,431	5,160
DELTA:						
Hand mining	16	75	100,954	384,969	6,310	5,133
Machine mining	4	35	131,676	448,821	32,919	12,824
LICK BRANCH:						
Hand mining	4	42	34,102	149,921	8,525	3,570
Machine mining	6	32	150,958	640,519	25,160	20,016
ROLFE:						
Hand mining	30	115	186,240	835,620	6,208	7,266
No. 6 COLLIERY:						
Hand mining	9	94	106,748	515,294	11,861	5,482
Machine mining	5	25	75,092	316,856	15,018	12,674
No. 7 COLLIERY:						
Hand mining	10	86	113,560	263,621	11,356	3,065
Machine mining	31	87	336,210	1,176,219	10,845	13,520
No. 8 COLLIERY:						
Hand mining	25	111	215,850	762,290	8,634	6,868
TOTALS:						
Hand mining	391	1,949	2,460,454	9,058,107	6,293	4,748
Machine mining	206	594	1,664,796	6,231,833	8,081	10,491

	Hand loading 1929	Hand loading 4 years	Mechanical loading 1929	Mechanical loading 4 years
Percent of total tonnage produced	59.6	59.2	40.4	40.8
Frequency rate (percent of lost-time accidents)	65.5	76.6	34.5	23.4
Severity rate (days lost per 1,000 tons of coal produced)	10.10	7.90	4.07	4.83

Note: In presenting the above comparisons, we have considered all accidents causing loss of time of one day or more, and have charged to machine loading all accidents having any connection therewith, such as haulage, timbering, track, etc. Main line and tipple accidents have been pro-rated on a tonnage basis and charged accordingly.

PHYSICAL EXAMINATION
in Relation to Accident Prevention

By Thomas E. Lightfoot *

THE tendency on the part of state legislatures during the past five or six years to liberalize compensation laws so as to provide increased payments to claimants for injuries sustained has been, of necessity, reflected in increased premium rates for compensation insurance. For example, the minimum rate on bituminous coal mining in Pennsylvania has increased from $1.60 per $100 of pay roll in 1926 to $3.30 in 1930, and corresponding increases can be found in the schedules in other coal producing states.

Compensation insurance is essentially an operating cost, and when we consider that on a basis of a production labor cost of $1 per ton, each dollar's increase in the premium rate represents an increase of 1 cent a ton in the cost of producing coal, we can more fully appreciate the importance of obtaining the lowest possible compensation rate. Probably this increase in compensation cost has been the most important factor in stimulating systematic organized accident-prevention work in the coal mining industry during the past five years.

Those companies that did inaugurate comprehensive accident-prevention programs soon realized that something more than simply educating these men in safety was needed, if their accidents were to be reduced to a minimum, and their compensation costs lowered, and that was to refrain from employing men who carried within themselves physical conditions that could easily contribute towards an accident, and who were potential compensation cases. And thus did the practice of pre-employment physical examination gradually become established.

Some coal companies have maintained physical examinations for the past 15 years or longer. These are primarily companies whose ownership is connected or affiliated with the railroad or steel industry, where such examinations have been carried on for many years or who maintain a pension system making such examinations imperative.

Since 1925 the number of coal companies employing physical examinations has steadily increased. The records of a large insurance company doing an extensive group-insurance business among coal companies are interesting in this respect and show that in 1925, three companies had physical examination; in 1926, nine; in 1927, twenty-two; in 1928, thirty-six; and in 1929, fifty-eight. The number is steadily increasing. The above represents approximately some 30,000 employes.

Physical examinations can usually be carried on at no cost to the mining companies. Where a physician is employed on a salary, this work is simply added to his duties. When the doctor is paid direct by the men through a pay-roll cut or check-off, it is likewise done without cost to the company, as the doctor usually takes on this additional work cheerfully, since he realizes he is saving himself from greater labor later on. When there is no doctor employed, examinations are made by some designated doctor, who may charge anywhere from 75 cents to $1.50 for each examination, depending entirely on local conditions and the extent of the examination. This is an expenditure that easily justifies itself.

Physical examinations may be as superficial or as thorough as may seem desirable to suit conditions and to conform to the policy of the employing company. Even a superficial examination will disclose many potential compensation cases, and companies having an extensive welfare program will go into the matter with much greater thoroughness. In either event, a permanent card record of every examination should be kept whether the applicant is employed or not, for frequently minor defects are uncovered which, if recorded, may have an important bearing on some future compensation award.

The more important physical defects uncovered by these examinations and which bear a definite relationship to accidents are:

Defective vision.—The number of men applying for work in the mining industry whose vision is so defective as to be almost blind is truly amazing, and the amounts paid out in compensation for eye injuries is tremendous, many of the injuries paid for are really a compounding of old injuries, or of defective vision, which, if known, would naturally alter the amount of the compensation award.

Hernia.—Hernia in itself is not compensable in most states, unless a radial operation is performed, in which case there is an expense for an operation of from $75 to $100, and in addition disability payments for a period of 6 to 12 weeks. A hernia actually caused by work in coal mining is extremely rare, yet compensation is paid for thousands of hernia cases each year because it is impossible to prove that the hernia was NOT caused while at work in the mines. The man feels a sudden pain, an examination is made, and the hernia is found, and compensation is in order, while it may be and usually is an aggravation of a pre-existing hernia. The value of examination in such cases is obvious.

Heart defects.—There is a wide divergency of opinion in the matter of rejecting men for various heart defects and each case must be judged by itself. The fact should be borne in mind, however, that bad heart conditions are usually associated with other diseases, making the employment of such a man a hazard. A man with a weak heart is particularly susceptible to death from electric shock, it being almost impossible to resuscitate such a person who is shocked by a live wire. The increased use of electricity in mining makes this a matter of importance.

Venereal diseases.—One reason for rejecting men with venereal diseases is the difficulty in getting complete and proper union of fractures in connection with injuries involving broken bones. I realize that some eminent bone specialists hold that syphilitic conditions do not retard such unions, but other equally eminent surgeons take a contrary view, so that it would seem to be the part of wisdom to refrain from employing men having venereal diseases.

Tuberculosis.—The disadvantage of employing men suffering from tuberculosis, with their correspondingly weakened physical condition, is obvious.

Miscellaneous.—There are other defects which do not occur in so great a number as the above which may sometimes justify refusing employment. These are ankylosis, bad teeth, defective hearing, missing members, etc. Since in the case of serious accidents more deaths occur from shock than from the injury itself, it is important that no man be employed whose vitality is so depleted by disease of any kind that he can not reasonably be expected to survive the shock of an accident.

Just to what proportion of applicants for employment are of substandard condition is indicated in the results of a year's experience of a large coal company. As this experience covers 12 mining operations spread over a considerable geographic area and representing an average pay roll of about 4,500 men, it may be considered as typical:

RECORD OF PHYSICAL EXAMINATION FOR 1929

	Jan. 1st to July 1st	July 1st to Dec. 31st	Total	Percent
Heart defects and diseases	64	42	106	18.7
Defective vision and blindness	52	54	106	18.7
Hernia	52	66	118	20.8
High blood pressure	36	58	94	16.5
Deformed or missing members	22	34	56	10.0
Veneral diseases	7	11	18	3.1
Tuberculosis	6	12	18	3.1
Miscellaneous defects	23	28	51	9.1
Total	262	305	567	100.0

Total number of men examined..... 8,502 Percentage rejected..... 6.6%

*Engineer in Charge of Accident Prevention and Compensation, the Koppers Coal Company.

The above record was kept for the first and second parts of the year separately to show the uniformity of rejections in the three major classifications. A further analysis of the records used to compile the above indicated that these classifications showed an almost uniform percentage of rejections, month by month, which is a matter of unusual interest.

All of the foregoing has been based on pre-employment examinations, nothing having been said concerning examinations of existing employes. It is a question whether the coal industry could stand having an examination of all men now employed with the idea of dispensing with the services of all of those who were found to be physically defective. There would be turned loose on the various communities an army of men who would be unable to secure employment elsewhere, thus creating a serious menace. However, an examination of men now employed for the purpose of record and with the idea of rearranging the duties performed by them, so as to secure maximum efficiency certainly is in order and should be done by every mining company.

Undoubtedly there are many men who are working at jobs to which they are unsuited by virtue of their physical condition and who could be given employment to which they are suited at no loss to the company. Many men have defective vision without knowing it, but this could be largely corrected. Hernia cases could be detected and an operation recommended. If declined, the record of the examination would be security against a possible future compensation claim. Sooner or later compensation carriers will ask for a copy of the physical examination record of all accident cases coming before them as claims, and the companies who are able to comply with this request will be in far better shape than those who can not furnish this information; as these records will have a marked bearing on the awards made.

While the purpose of this paper has been to emphasize the importance of physical examinations in accident-prevention work, there is another angle, however, that is equally important, and that is the increased efficiency of selected employes. Physically sound men are more likely to be 100 percent producers than those unfit, and this factor, combined with the savings effected from a compensation standpoint, fully justify physical examinations.

DISCUSSION

Physician Examination in Relation to Accident Prevention

William Roy, *safety director, Wheeling & Lake Erie Coal Mining Company:*

The discussion that I would make on this paper is from a practical viewpoint, and from close associations gathered with the man in the mines over a long period of years, also from viewpoints as expressed in the policy of the company for which I work.

It is hardly necessary to discuss or comment upon this paper, because it covers the subject very thoroughly, and one can add very little to it. There is one thing that is pleasing to me, and I believe this is one of the subjects that contains the thought that makes this meeting a pleasing one. We have heard a lot about mechanical mining and improved machinery. I have also heard something about humanism since I came to this particular meeting, and this problem that we are now discussing deals with that phase, and it is dealing with a very necessary problem in the mining industry.

It is so important that a short time ago our company decided they would have physical examinations, and we wanted to be right about the policy, we wanted to be fair. We wanted it to be a business proposition, and we wanted to treat the men who applied for work in our mines in the most considerate way possible.

The general manager had us write up a theory of medical examinations, so there could be no mistakes made and so the policy of the company as outlined in this theory of examination could be placed in the hands of the local mine management, that the same rules that applied in the examinations at one mine would apply at all mines, and so the different thoughts of different men would not be applied at their own particular mine.

During the few months we have had the medical examinations we have found that all the facts that the paper just read has brought forth were absolutely true. We believe that any man injured while at his work should be compensated, but we believe that no one should burden industry with defects that existed prior to employment. This is the policy that we are working on at the present time, and we find that physical examinations prior to employment reveal these defects.

I agree with Mr. Lightfoot when he says that it would be impossible to examine all the men now employed in the mining industry. I don't believe that time will ever come. It might be a good thing if it did. I believe it would solve the problems of the mining industry, because there would be so few men left, there would be no overproduction, and certainly no competition.

In the mining industry medical examinations are something new. In starting something new we ought to be very careful; we ought to be sure that it is right. After having become assured that it is right, we should see that it is handled in the right way. Physical examinations will not be as effective as they should be until the worker realizes the advantage of such examinations.

To have him realize the advantages of physical examinations there are a few "don'ts" that ought to be placed in such a policy. One of these "don'ts," in my opinion, is that it should never be called a welfare program. I do not believe the worker relishes the idea of welfare work. I believe he rather resents it.

I would say to make of it a business proposition. It will help make a sick industry well. It will also help make a sick man well. It is good business for all concerned.

I believe that if mining companies are making enough money to engage in extensive welfare work, that more of it can be done by putting that money in the pay envelope than by trying to devise some paternalistic program. I believe the employes would enjoy it more.

Then there is another "don't" in connection with this, and that don't is not to use physical examinations as a blind to establish an age limit. If you are going to have an age limit, make it public, but do not use physical examinations as a blind to establish it.

There is another "don't." Let it not be used as a subterfuge to refuse men employment or to discriminate against them. There are many complaints that arise over this question. Men contend they are refused employment because of personal reasons. They are sent to the doctor, and the doctor refuses them employment on the grounds of physical defects, when such is not the case. This is not fair to the man seeking work in the mines. It sours him against humanity. It might worry him into believing he has something wrong with him when he really does not.

It is my opinion, as I said before, that in the beginning of physical examinations in the mining industry extreme care should be used at all times in carrying out the program. We should use care in trying to see that none of these "don'ts" that I have mentioned enters into it. I have always found this: Society nor industry never banished, never displaced, nor never discarded a human being without at some future time establishing some kind of a system to care for him.

You generally find the cost of caring for him amounts to more than the saving gained by displacement. For instance, the large mill companies and the railroad companies provide insurance and old age pensions. Legislative bodies are considering the same thing. The length of time it will take to get it depends on how many men are displaced. Society pays for its banished members in fires such as recently occurred in Columbus.

ROCK DUSTING PRACTICE at Penelec Mine No. 5

*By D. L. Boyle**

THE question of how to rock-dust a bituminous coal mine has been asked by many coal operators, and many of them have the impression that a thoroughly rock-dusted mine is expensive. This impression on costs is wrong, as my experience has shown that it is inexpensive either on a linear foot or a tonnage basis.

In Indiana County, 10 miles from Johnstown, Pa., we have rock-dusted Penelec Mine No. 5. This mine is owned by the Penelec Coal Corporation, which is a subsidiary of the Associated Gas and Electric System. The coal from this mine is used for generating power at the central power station, Seward plant.

The bed of coal mined is the Lower Kittanning and averages 42 ins. in height. The analysis is 17.72 volatile matter and 70.04 fixed carbon. The coal dust in this mine is recognized as explosive and the mine is gaseous.

This mine has required a great deal of attention because it has a history of two mine explosions. The first occurred on March 30, 1916, in which eight men were killed. This explosion was caused by an open light igniting gas. The second occurred on April 3, 1917, in which three men were killed, and was caused by a defective mining machine cable at the face, after a door had been left open by a workman through carelessness.

In 1920 our company purchased this mine, and we have put forth every effort to make conditions as safe as it is possible, hence, when rock-dusting was strongly advocated by the United States Bureau of Mines, we investigated it thoroughly and in 1925 started rock-dusting.

Before starting to rock dust, a mine should be given a thorough cleaning up of all old materials which accumulate, and also coal and rock should be cleaned from the roadways.

After cleaning up, samples should be taken all over the mine to show the percentage of incombustible matter present on the roof, rib and bottom. This report will show you the amount of rock dust required to put your incombustible percentage up to the safety-factor as recommended by the United States Bureau of Mines; namely, 55 percent. This incombustible percentage is also required by the Department of Mines in Pennsylvania and the Pennsylvania Bituminous Coal Mine Compensation Rating Schedule.

Before starting to rock dust, our incombustible matter ranged from 8 to 31 percent, and after applying 8 pounds per linear foot, we increased this up to 80 percent and better. We use a dust, 80 percent of which passes through a 200-mesh screen. A recent experience we had was on a car of dust came in that averaged 93 percent through a 200-mesh screen and it would block up our distributer, because of its fineness.

Rock-dusting was started on February 16, 1925, at Penelec Mine No. 5 with a low-pressure M-S-A distributer. This distributer gave good service, and by using two regular men at this work, we could get 5,000 lin. ft. of entry dusted with 4 pounds of dust per linear foot on an 8-hour shift.

Our entries are driven 24-ft. wide, as we gob rock inside our mine. The roadways are 10-ft. wide by 6-ft. high. The gobs are not tight, therefore we can get the entire entry thoroughly rock-dusted.

In 1925, along with our entry rock-dusting, we erected barriers of the "V" type in our aircourses and abandoned sections which could not be dusted with the distributer. The barriers were constructed in such locations that if an explosion occurred, it would have to go through at least two barriers in any direction. In this, we figured it would be about impossible for an explosion to travel very far. At this time, we have 133 complete barriers erected, with each barrier containing 100 pounds of rock dust per square foot of entry cross-section at the barrier location.

4 pounds of dust per linear foot. These aircourses and rooms average 60 sq. ft. of cross-section.

To rock-dust our entries, aircourses, manways, and rooms thoroughly, we give two complete dustings or about 8 pounds of dust per linear foot, and try to keep an average of 80 percent incombustible matter at all times. Producing entries and rooms will require more dusting, but by taking samples each month all over your mine, you will know exactly what sections need dusting and how much dust to apply.

In this mine we have rock-dusted twice each year, with the exception of places in which the percentage of combustible matter is found to be dangerous, and in such cases it is done as often as prevailing conditions require.

We require a report on rock-dusting for each shift worked, and send to the office along with the daily coal report, and in this way an accurate record is kept of what rock dusting is being done and what it is costing.

Records of actual work done in rock-dusting from February 16, 1925, to April 1, 1930, are given as follows, along with costs for the purpose of showing that rock-dusting properly maintained is not expensive nor prohibitive.

Year	Linear feet rock-dusted	Pounds of rock-dust applied	Avg. Lbs. of rock dust per lin. foot	Labor cost applying dust	Cost of dust in the mine	Total cost of dusting	Cost per linear foot, cents	Tons of coal mined
1925	100,131	398,818	3.98	$607.90	$1,502.87	$2,110.77	2.10	145,715
1926	66,190	211,930	3.22	313.16	741.76	1,054.92	1.59	149,167
1927	96,750	287,452	2.97	327.89	1,006.05	1,333.94	1.37	171,243
1928	73,895	244,367	3.31	220.20	775.87	996.07	1.34	161,538
1929	64,140	244,260	3.81	214.40	702.52	916.65	1.58	161,669
1929	132,400(A)	525,460	3.97	1,280.40	1,510.70	2,791.10	2.11	
1930 (3 months)	33,590(A)	133,360	3.97	247.77	384.41	632.18	1.88	35,740

(A) Shows high-pressure dusting during 1929 and 1930.

In January, 1930, a report (R. I. 2977), on rock-dust barriers by the United States Bureau of Mines, reduces this amount required to 60 pounds of dust for each square foot of cross-section at the barrier location. This will provide sufficient dust to stop coal-dust explosions of moderate violence.

Since erecting barriers, we have gone to rock-dusting aircourses, rooms and manways with a M. S. A. high-pressure distributer of an approved design, and are satisfied that more effective dusting is accomplished and the cost is greatly reduced. Our manways, aircourses, and rooms are 42 ins. high, and for this work we use three men. One man stays at the distributer and keeps the dust moving and two men work the hose in the low workings. This work is strenuous, and with all the handicaps of low coal our men average 2,000 ft. and better for an 8-hour shift and apply an average of

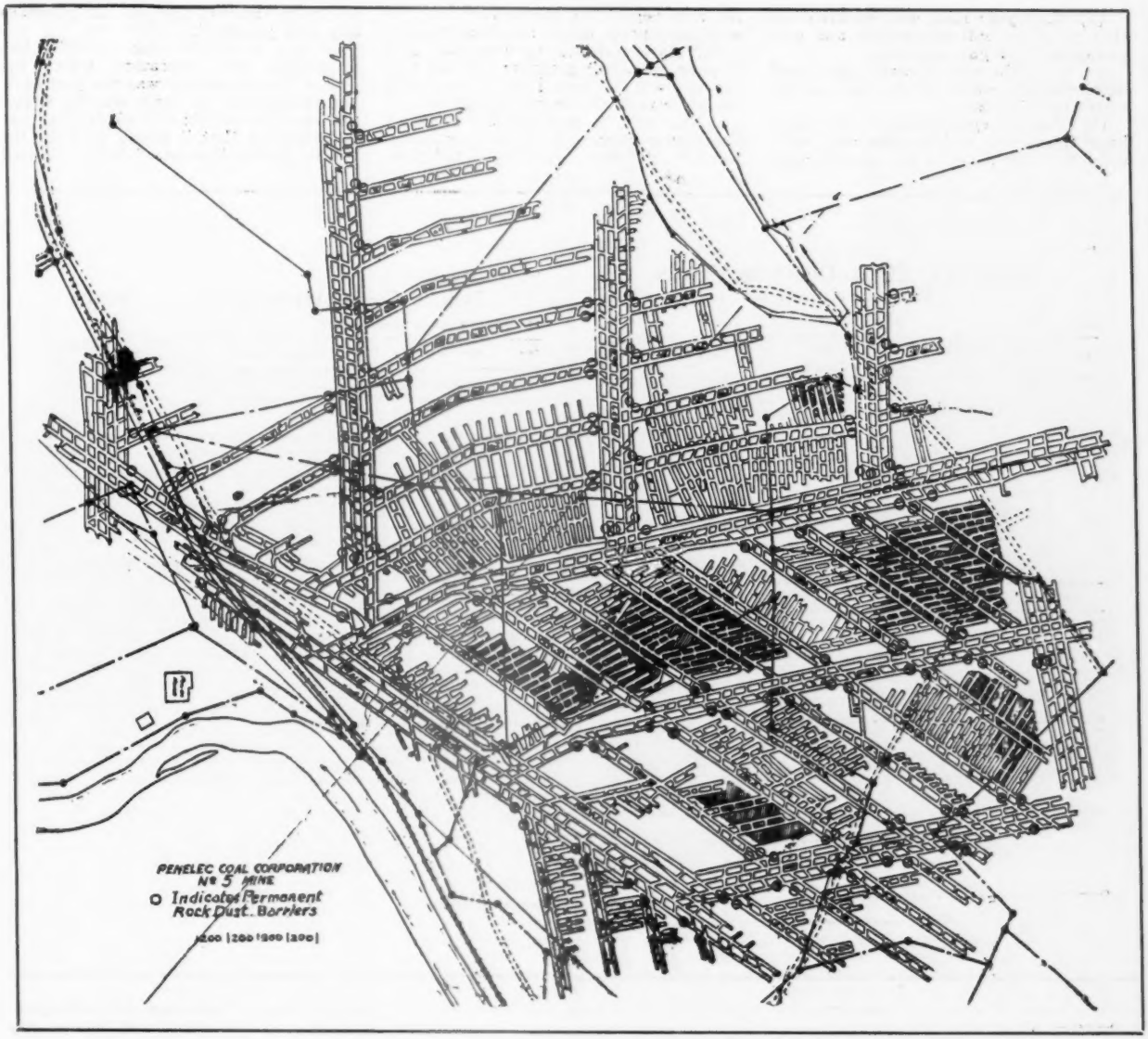
Prior to 1929 this mine received credit for rock-dusting, but in 1929 the requirements were changed and this necessitated doing room, aircourse and manway dusting the same as on haulage roads. To get this credit it is necessary for us to comply with the new rating schedule.

At the time of preparing this paper it is expected that this mine will be completely rock-dusted by the last of April, at which time we expect to receive a credit for this work from the Pennsylvania Bituminous Coal Mine Compensation Rating Bureau.

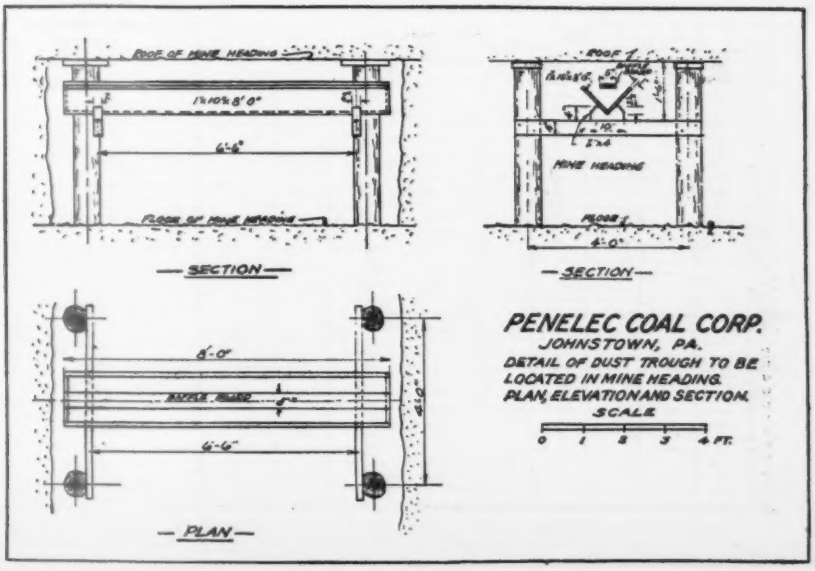
The question may be asked as to the cost of completely rock-dusting a mine and we have the following development: 57,200 linear feet of haulage road, 96,400 linear feet of aircourse and manway, and 82,400 linear feet of rooms and pillars.

On haulage roads we use a low-pressure distributer which in 5 years gave us an average cost of 1.598 cents per linear

* General Manager, Penelec Coal Corporation.



Mine map showing location of rock dust barriers



Construction details of dust troughs used

foot. For aircourse, room and pillar dusting the high-pressure distributor is used and our average cost now is 2.062 cents per linear foot. Both of these prices are based upon using 4 pounds of rock dust per linear foot, and the total cost to rock dust a mine such as the writer has outlined would be $4,600 plus the purchase of a rock-dust distributer. The cost would bring the mine up to the required 55 percent incombustible matter.

As to the cost of rock-dust barriers in Penelec's mine No. 5, they represent $95 each installed. A large item of this cost is due to the low coal in this central Pennsylvania field.

Summarizing all of our experiences gained in rock-dusting, the writer would make the following recommendations:

(1) Keep your mine well ventilated so that no gases will accumulate and give you cause for a gas explosion.

(2) Keep the mine cleaned up of coal dust, sprinkle water at the face on the cutter-bar if possible.

(3) Have a regular trained crew who know how to do rock-dusting and insist upon it being done in the proper way, for any neglect or carelessness in this work may prove costly and disastrous.

(4) Have rock-dusting a regular part of your operating program and the cost per ton will be very little if the mine officials give it the proper attention.

In the past, it was difficult to get a distributor to do all kinds of dusting, but now, different types of distributers are on the market and you can purchase any type you need.

It may be stated that in 1924, two prominent coal operators asked the writer if rock-dusting was not just some person's dream; the reply was the writer had seen the effects of rock-dusting and was satisfied that it would do what the United States Bureau of Mines claimed

Form 11 138

PENELEC COAL CORPORATION

DAILY ROCK DUSTING REPORT

.....Mine ..... 19.....

Heading	Average Cross Section	No. Feet Applied	TIME APPLYING			Total Labor Cost	Pounds of Rock Dust Used	Average Pounds Used Per Lineal Foot
			No. Men	Total Hours	Rate			
TOTALS								

Note delays here:

State here, point of starting and where quit rock dusting:

Report made out by.....

.....

Checked by:.....Mine Foreman

.....Superintendent

Form 17 130 1326

Penelec Coal Corporation, No. .....Mine

RECORD OF ROCK DUSTING SAMPLES

Date	By Whom Collected	Heading and Location	Per Cent. of Incombustible		
			Bottom	Roof	Sides
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					
31					

REMARKS:

Above Samples Analyzed by .....

Form 18 SC 1324

PENELEC COAL CORPORATION

MONTHLY REPORT OF ROCK DUSTING

.....Mine Month Ending.....

Date	Total Lineal Feet Applied	Average Cross Section	Pounds of Rock Dust Used	Average Pounds Rock Dust per Lineal Foot	Cost of Applying Rock Dust	Cost of Rock Dust	Total Cost	Cost per Lineal Foot	Daily Tonnage	Cost per Ton
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
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28										
29										
30										
31										

Forms used for keeping rock dusting records

for it. One of these men did thoroughly dust one of his mines and had a gas explosion, and the investigation proved that rock dust was the cause of reducing the effects of the explosion and the saving of lives. The other operator rock-dusted partly and he also had an explosion which resulted more seriously, due to the lack of care in having the rock dust applied and failure to keep the incombustible percentage at the safe average as recommended by the United States Bureau of Mines.

In conclusion, the writer feels that rock-dusting should be rigidly enforced where it is required to protect the lives of our miners and property, as effective rock-dusting will, and has, prevented serious mine explosions.

The Penelec Coal Corporation feels that the amount of money expended in this work has been justified since it has completely changed the sentiment of the employes and their families as they now have the feeling of added protection and safety. The property is also protected and rock-dusting is really an insurance in itself against explosion hazards.

This paper is presented to your Mining Congress and the data given may be used in any way which might be of benefit to the coal-mining industry.

The Safety Award Winner

Presentation of the "Sentinels of Safety" Trophy to Hull No. 33 Mine, De Bardeleben Coal Corporation

J. J. Forbes, *U. S. Bureau of Mines:*

I am certainly pleased to be privileged to represent the bureau in presenting this beautiful trophy to a mining company that has achieved such an outstanding record in safety and accident prevention work.

Each year the National Safety Competition conducted by the Bureau of Mines for "The Sentinels of Safety" is carried on through the good graces of the *Explosives Engineer Magazine.*

I want to call your attention at this time to the awards made under the bituminous group. The five mines having the lowest accident severity rate in the contest for the bituminous mine trophy, "Sentinels of Safety," the first one is the Hull No. 33 bituminous mine, in Alabama. I will give the details on this record later. But I do want to call your attention particularly to the other four mines that have received honorable mention.

The first of this number, with an accident severity of .285 is the Corona No. 16 bituminous coal mine, Walker County, Ala., which worked 378,478 man-hours in 1929 with five lost-time accidents, causing 108 days of disability. This mine is operated by the DeBardeleben Coal Corporation.

The second mine that has received honorable mention, with a severity rate of .305, is the Corona No. 12 mine, Corona, Walker County, Ala. This mine worked 190,485 man-hours in 1929 with three lost-time accidents, causing 58 days of disability. This mine is operated by the DeBardeleben Coal Corporation.

The third mine in this group that has received honorable mention for the calendar year 1929, with a severity rate of .395, is the Dawson No. 5 bituminous coal mine, Dawson, Colfax County, N. Mex. This mine worked 169,740 man-hours in 1929 with two lost-time accidents, causing 67 days of disability. This mine is operated by the Phelps Dodge Corporation, Stag Canyon Branch.

The fourth mine to receive honorable mention, with a severity rate of .482, is the Stewart bituminous coal mine, Southwest, Westmoreland County, Pa. This mine worked 429,903 man-hours in 1929 with five lost-time accidents, causing 207 days of disability. This mine is operated by the W. J. Rainey, Inc, Uniontown, Pa.

I think it would be a mistake if I didn't call attention at this time to the splendid record of the Stewart mine of the Rainey Company. This mine has been in operation for 10 years and 4 months, produced in the neighborhood of four and a half million tons of coal, with an exposure of approximately 5,000,000 man-hours without a serious disabling accident. The mine was abandoned on April 1, 1930. In other words, here is a coal mine that has gone through its entire life without a fatality or without a serious disabling injury.

To come back to the award for the Hull No. 33 mine of the DeBardeleben Coal Corporation: This mine, as I stated before, is operated by the DeBardeleben Coal Corporation, with offices in Birmingham, Ala.

The record of the mine is as follows: It had three accidents, causing a total of 21 days of disability. Its accident severity rate was 0.079, as compared with 11.571 for the whole bituminous group. The frequency rate for the Hull No. 33 mine was 11.3, while that for the group was 88.9.

The exposure for the winning mine was 264,656 man-hours, while that for the entire group was 33,668,473 man-hours.

I think that the greatest record that can come to an individual or a group of people who have achieved outstanding success in the undertaking of this feat is the self-satisfaction of knowing and feeling that they have done their task well. Notable achievements in every line of human endeavor seldom escape the attention of an appreciative public, which is constantly seeking opportunities such as this to make publicly known the appreciation of such an achievement. The achievement of the DeBardeleben Coal Corporation is of the highest order—the conservation of human life.

This company has demonstrated that the hazards connected with our important basic industry—coal mining—can be successfully controlled by organized, cooperative safety effort on the part of management and men. This company has set an example in the promotion of safety that will be far reaching in its effect and encourage employers and employes throughout the United States to strive for a similar record.

In behalf of the United States Bureau of Mines I present this beautiful bronze trophy, donated by the *Explosives Engineer Magazine,* to Mr. Fies, vice president and general manager of the DeBardeleben Coal Corporation. Will you please come forward, Mr. Fies?

Mr. Fies, may I express the congratulations of Scott Turner, the director of the Bureau of Mines, on this notable achievement. I hope that Mr. Fies will bring out some of the outstanding things that have made this record possible. I have talked to him about the matter, and he was modest. He doesn't want to point out some of these things, but I hope he will do so. I think that the Congress will appreciate, Mr. Fies, your pointing out the high points that brought about this splendid record.

Milton H. Fies, *DeBardeleben Coal Corporation:*

I am very grateful to the Bureau of Mines and to the *Explosives Engineer* for this trophy, and to Mr. Forbes for his expressions, which are very, very much appreciated.

I am somewhat reluctant to talk about an accomplishment such as this, because, as you know, it is always difficult to talk about an accomplishment without creating an appearance of boasting. That is farthest from my thoughts. I want to give the breaks of the game due credit right here. At the same time, although I may mar my previous statement, it has been my experience that an organization that works the hardest for safety, who is most diligent and earnest, usually gets the best breaks. No one man in our organization is responsible for our splendid record. It has been coordination all down the line, from the president of the company to the lowliest trapper who works in that mine.

Hull is a drift mine; the drift enters the mountain for about 2,000 ft., where a fault with a 50-ft. throw was encountered. There is a hoist at the fault. Locomotives convey the coal from the fault to the tipple. Below the fault the coal is gathered with mules.

The coal is undercut with electric machines and shot with permissible powder. The seam is from 6 to 9 ft. thick, has draw rock from 4 to 6 in., the top above that draw rock being fairly good.

The men at that mine have had 100

percent first-aid training. Our experience has been, in our own company, that the number of men who are injured, who have first-aid training, as compared to those who have not are about 1 to 8. Most of the men at this mine live in villages surrounding it. When the Government sent its car there, we had to figure out some way to get those men to stay after their work to take this first-aid training. For the four or five days that the car was at that mine we furnished their suppers. In other words, the men came to the mine, and they stayed on the job; we furnished their meals until they had had this training.

Our accident record throughout the entire company, which is reflected by the record at this mine, is, in my opinion, due to a change in the application of discipline throughout the organization. The choice of a method of discipline and whether or not to enforce such discipline has been removed from the superintendents and foremen. We have fixed safety rules and, if a man violates a rule, he is warned the first time, suspended the second time, and discharged the third time. We put that disciplinary rule into effect in 1926, and by just glancing at the graphic chart of our accidents you will notice that the line dropped abruptly at that point.

Why did this change in the application of discipline improve our accident record? We had previously found that it was almost always impossible for a foreman or a superintendent to get away from his personal relationship with the employe. For example, if a superintendent or a foreman at a mine which performs the cutting of coal at night is short a machine man and, after hours of search through the village, perhaps in the rain or cold, he finds a man who is willing to "double back," it is altogether improbable that, if the machine man who accommodated the superintendent or foreman violates a rule the next day, he will be disciplined by the man whom he favored. This is merely an example of what might happen in many incidents connected with the operation of a mine.

We find frequently that a foreman does not care to incur the ill will of the men by enforcing discipline.

Consequently we adopted the rule that the employe who violates a rule *must* be warned for the first offense, he *must* be suspended for the second offense, and he *must* be discharged for the third offense.

Among 3,000 men with a rule of this type in effect for four or five years we have had to discharge only two men.

Another feature in connection with our safety standards which has been helpful, particularly at Hull, is that we have a fixed timbering rule. We had many experiences prior to the adoption of this timbering rule, where men who had been in the mines many years would tell our inspectors that they needed no advice as to when and where to set a prop. To overcome this type of objection, we made a study of the situation at each mine, and, after consultation with the men, fixed rules were adopted with reference to distances for the setting of props along roadways and across faces of working places. This means that props are to be set at these intervals whether or not the miner considers the top good, and at the same time does not relieve him from setting them closer if the top is, in his judgment, bad.

Hull mine operated 167 days last year, 14 days per month, with an average production of 900 tons per day. While this is not a very large mine, we employ in and around the preparation plant and washer and underground about 165 men.

Our company inspectors, along with the splendid work that has been done by the state inspection department, have contributed to our record.

We are not interested particularly in the company inspectors making out long reports about defects that they find; we insist that inspectors, when they find a condition that is unsafe, stay with it until it is corrected—not just write it up and then have to go back and report it again. We have found this to be most helpful.

Another system that we have inaugurated may be of particular interest to some of you safety men present. It is our red inspection tag, or danger tag, system. These tags are numbered consecutively, with perforated stub, both stub and tag bearing the same number. On the face of the tag are the words, "This Condition is Dangerous—Correct It," and space for the name of the mine, the location of the dangerous condition, the date, and a description of such condition. For example, an inspector writes on the card, "Guard off of pump," giving its location, etc., and places the tag on the pump. Then he fills out the stub, stating that the defect mentioned on the tag, viz, guard off pump, its location, etc., was tagged for correction. This stub is turned in to the superintendent.

Now, on the back of the tag attached to the defective machinery are these words: "This condition was corrected on .... date," with space for the signature of the repair man. This tag is likewise turned into the superintendent.

When the superintendent receives the stub from the inspector he knows of the dangerous condition found, and when the repair man brings in the upper part of the tag he knows such condition has been corrected. If the tag does not come in, it is his duty to find out the reason why. We have had many cases where the repair man got the tag back to the superintendent's office, showing the condition corrected, before the safety inspector had had an opportunity to turn the stub in. This system, you will note, eliminates delay. And, besides, these red tags about a surface plant, or underground, giving the place the appearance of a Christmas tree, do not appeal particularly to a conscientious foreman or superintendent, and, as a result, this tag system has improved safety conditions.

Then we have at each mine safety committees composed of both whites and negroes. They make regular inspections of the mines and report on conditions as found. They also report on all serious accidents and attend our monthly safety meetings.

These monthly luncheons, or meetings, are held in the county seat of Jasper and are attended regularly by all foremen, superintendents, the general superintendents and the operating vice president.

At these meetings all accidents are listed which occurred the previous month. Each superintendent is required to go to the platform and explain the accidents at his mine. You can imagine how he enjoys that! It is a further inducement for him to do his best to see that there are no accidents to explain. There is another good thing that comes from it—each superintendent knows his accidents. It would be quite embarrassing for a superintendent to get up before that crowd of men and attempt to explain how an accident occurred without knowing the facts.

At these same meetings no-lost-time accidents are also discussed. As you men know, there is often only a very small step from a no-lost-time accident to a lost-time accident.

The meetings are followed by a luncheon, there being separate arrangements made for the white and colored men. In this way the management is given an opportunity to meet and know the men. The men in our organization know that foremen and superintendents can not hold it against a man, who has served on a safety committee, for reporting defects for which that foreman or superintendent might be responsible. Those men know that every foreman and superintendent we have must go 51 percent of the way in their attitude toward them as far as safety is concerned.

We have a company paper, a portion of which is devoted entirely to safety. First-aid treatments of various kinds are illustrated and for the benefit of the men information about safety records is promulgated.

In 1926 the compensation insurance company advised us that they were going to raise our rates 50 percent. We decided to carry our own insurance and used the old rates as a basis of comparison. We carry catastrophe insurance of limits of $10,000 to $300,000 at each mine, costing from 14 to 15 cents per hundred dollars of pay roll. Only one of the mines of our entire group is gaseous. We charge against that old rate all expenses connected with the casualty and safety department, including the luncheons and other expenses, and our average profits for a year have been from $15,000 to $17,000, using, as stated, the old rates for comparison. So, aside from the higher and finer purpose in this work, there results from it material saving, which is, in my judgment, very secondary.

I do not know that there is anything else that I can say. I am grateful to every man in our organization. The general superintendent of Hull mine is here. The chief of the Department of Mines of the State of Alabama, Mr. W. B. Hillhouse, is here, and he has been most energetic and helpful.

I think the trouble in our country, if you will pardon me, is that the higher officials of our coal companies do not take the proper interest in safety. I attended a general safety meeting in Birmingham last Saturday. There were only two executives of large coal companies present. The others were represented by some of their employes. Had that been a meeting involving policies of sales, matters of policy with reference to politics, or other things, the presidents and vice presidents of the coal companies in Alabama would have been there with bells on.

Sometimes I think we have the wrong standard. The higher officials of the coal-mining industry of the United States have an opportunity to contribute something to the age in which we live, and they should take advantage of the opportunity. If they will do more to further the cause of safety in the United States, results will be forthcoming.

I want to say again that I am grateful and that I have a deep sense of responsibility connected with this trophy. If earnest effort on the part of the organization of the DeBardeleben Coal Corporation will keep that trophy in the Sunny South, you may rest assured that it will stay there for many, many years.

A 100 percent PIT CAR LOADER Operation . . . . . in Illinois

*By F. S. Pfahler **

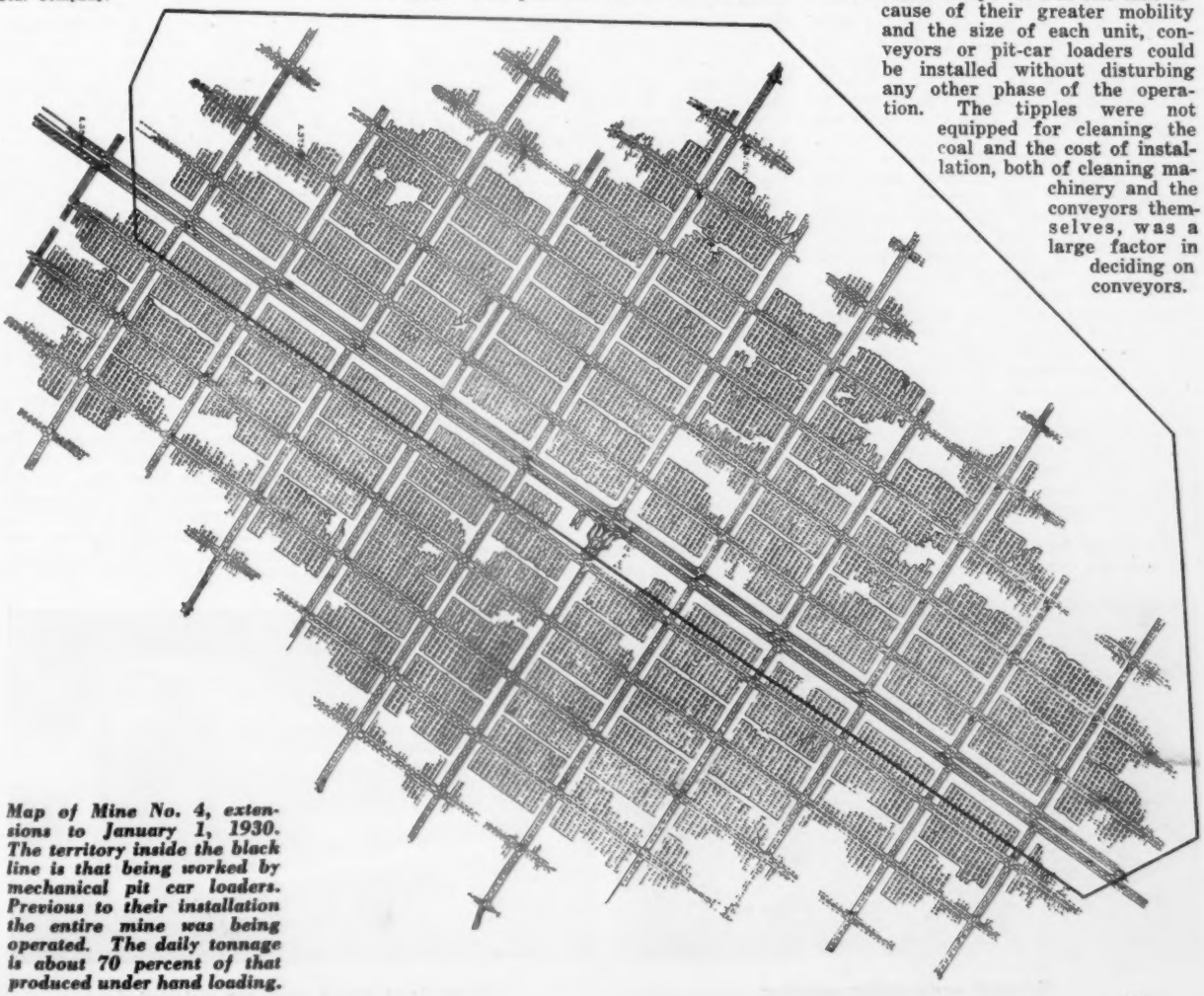
THE questions frequently asked in regard to the conveyor operations at the Superior Coal Company properties are, "Why use pit-car loaders?" or, "If you had it to do over again would your plans be the same?"

In order that the answers to these questions be properly understood it might be well to give a picture of the operations prior to the installation of conveyors. The Superior Coal Company is a subsidiary of the Chicago & North Western Railway Company, and operates four mines in Macoupin County, Ill., with a maximum daily capacity of 22,000 tons. With the exception of coal sold to employes the entire output is taken by the parent company. The mining is done in the No. 6 bed, which in our district is fairly level and averages 7 ft. in thickness. There is little water in the mines and the roof is what is usually found overlying the No. 6 bed, varying from an inch of clod to 20 ft. of soft gray shale; slips and horsebacks are usually in evidence. There is no standard method of timbering and where cross bars are used they are "yankee sets" or square timbering. The haulage is with 15-ton electric locomotives, and the gathering with 6-ton reel and cable or storage-battery locomotives. The main-line tracks are 40 and 50-pound rails, and the rooms are laid with 20-pound steel. The plan of work is a modified panel system with entries 12 to 21 ft. wide, and rooms 25 to 30 ft. wide.

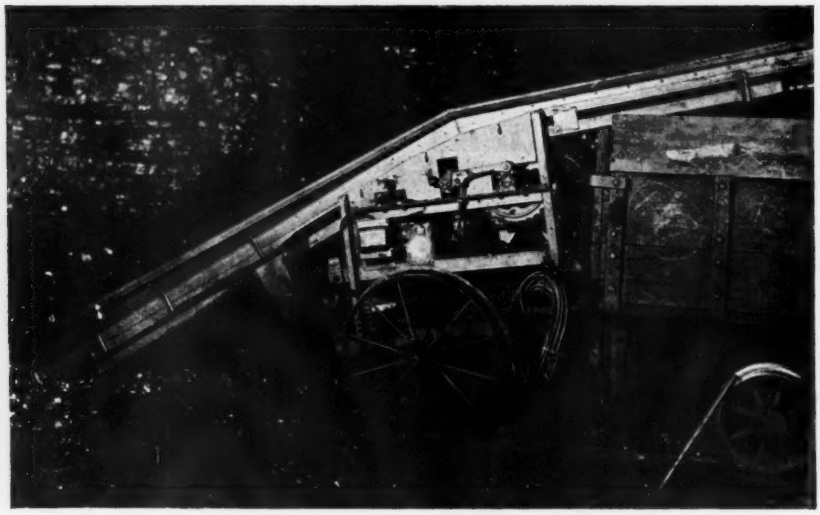
The undercutting equipment was breast machines which cut for 14 loaders, or shortwall machines which cut for 24 loaders, and the machine men operated the undercutting machines on a tonnage basis. Each pair of loaders was entitled to two working places, not counting crosscuts, and for all practical purposes and intents these places belonged to the loaders. The loaders furnished their own tools and explosives and were paid a tonnage rate which included drilling, shooting, loading, and straight timbering at the face. Yardage was paid on all entries 20 ft. or under in width. All other work done by machine men or loaders was considered dead work, and paid for on an hourly basis. The different kinds of work calling for extra pay were to numerous for any one man to remember.

It was early known that as far as the Superior Coal Company was concerned the most successful plan of mechanical operation would be on a 100 per cent basis. The reasons for this are both practical and psychological, as with both methods of work in the same mine countless reasons for disagreement and discouragement will arise. Questions of turn, wages, hours of work, rights to working places and such would be a constant hindrance to proper management and efficiency. It was felt that because of their greater mobility and the size of each unit, conveyors or pit-car loaders could be installed without disturbing any other phase of the operation. The tipples were not equipped for cleaning the coal and the cost of installation, both of cleaning machinery and the conveyors themselves, was a large factor in deciding on conveyors.

* Vice President and General Manager, Superior Coal Company.



Map of Mine No. 4, extensions to January 1, 1930. The territory inside the black line is that being worked by mechanical pit car loaders. Previous to their installation the entire mine was being operated. The daily tonnage is about 70 percent of that produced under hand loading.



Type of pit car loader being used

Because of the capacity of the mines being greater than the demand we were able to shut down one of the mines in February, 1928, and in this mine 10 pit-car loaders with electric drills and necessary tools were installed for experimental purposes; then our trouble began.

The writer does not want to say anything that would discourage anyone who wishes to install mechanical equipment, neither would he want anyone to believe that all that is needed is to purchase the machinery and then send it to the mine with the idea that the troubles are over. If one is not prepared to change a lot of his ideas of coal mining, men, and management; if one does not want to pass some sleepless nights; or does not care to go into some minute details of operation with the foreman, he had better let the machinery alone.

While we expected to make a few changes when conveyors were installed, we did not expect to have to change everything. An enumeration of some of our problems might be interesting, although it happened as it always does that the problems that seemed hardest to solve, somehow solved themselves, and the easy ones took considerable time and thought, but when the plant was finally put on a working basis it was difficult to recognize it as the same mine.

The writer does not think that anyone has a more loyal and efficient set of foremen than we have, and one would not suppose that our greatest problem was in our own official family. Yet, it seemed that the men at the mine talked one language and we talked another, and the mistakes were by no means confined to the men at the mines. The inside foreman was on an altogether different basis, as the work had to be laid out not only for the tracklayer, timberman, motorman, etc., but for the loader and machine man as well. The man at the face was now on a day basis instead of a tonnage basis, and the question of responsibility had to be readjusted, with the foreman having a more direct responsibility for the drilling, snubbing, and shooting. Some of the foremen seemed to go in one of two directions, neither of which was proper. Either they allowed the men at the face to go without proper supervision or they would tell the miner once how the work was to be done and if he failed or refused, would discharge him. These difficulties were ironed out when everyone realized that you can not radically change ideas or methods of work over night. When men have become accustomed after a lifetime of experience to doing a piece of work a certain way, they unconsciously continue to perform it that way. Although the changes were difficult they were interesting, and the writer rather believed that some of our foremen were taking the pit-car loaders home with them at night! In spite of our patience it was necessary to make some changes in foremen.

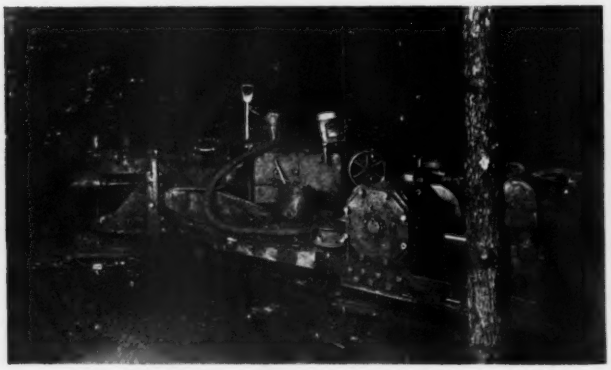
After the complete installation of conveyors, our next problem was one of unit of work. It might be possible to save money on loading and throw the money away in overhead, undercutting, haulage, timbering, tracklaying, or in some other classification. No good is accomplished by undercutting more than can be loaded or loading more than can be gathered. Sometimes the efficiency of one part of the operation has to be sacrificed to the well-being of the other departments. The stepping up of one part of the operation affects all of the other parts. After considerable experimentation we now have the present unit of operation:

Machine-men (2 shortwall machines)	4
Haulage-men (2 motors)	4
Track-men	3
Drillers and shooters	4
Timbermen	2
Material and repairs	2
Loaders (16 or 18 conveyors)	32 or 36
Total men	52

When mounted cutting machines are used there is only one machine with two machine men on each unit.

After the forces were properly organized, the territory worked in the mine was grouped by units to provide the best management by the unit foreman and the most efficient handling of pit cars by the gathering motors. This allowed concentrating the forces working at the face, thereby reducing the cost of maintaining tracks in stub entries and increasing the amount of recoveries made at less risk, especially where timber is not subject to the weight of the roof for so long a time.

It is always difficult to give due consideration to other folk's troubles as we all believe we have enough of our own. When a man operates a machine on a tonnage basis the lack of sufficient power is to extent his own trouble, but when he operates that same machine by the day the worry is on the shoulders of the man who pays the wages. We found out some things about our power and our transmission lines that we did not believe existed—rails without bonds, wire nailed on props, splices that could not carry the load. Besides this we had increased the load and additional wire and sub-stations had to be installed.



Mounted undercutting machine

Depot from which tools are distributed

Other than the added equipment for loading the concentration of the inside working called for a different power line-up.

In trying to perfect the method of mechanical pit-car loading we have tried not to overlook the disadvantages in this method, and it may be said that as long as the miner received only what was due him for every ton of coal loaded by hand, his employer was satisfied that the payroll was reasonably accurate because the labor cost for pit-car loading, which is more than 50 per cent of the total pay rolls, is based on the actual weight of the coal produced.

Under the present method of mechanical pit-car loading, the labor expense incident thereto is based on a wage scale at a daily rate of pay. Therefore, to verify the time allowed employes by the unit foremen we have employed a time checker at our mechanical mines, who maintains custody of the life checks until the employes call for them at the end of the day's work. The daily time reports made by the foreman are checked against a time report made by the time checker. Since this system was adopted we have done away with all questions concerning any omission of time due employes and relieved the foreman of a great deal of grief and embarrassment; in fact, we changed all of our accounting in so far as it concerned the mechanical mines. For the benefit of the foremen as well as the office the reports were based on the cost of production of each unit.

The quality of the coal produced is, and will continue to be the reason for much study. The coal is cleaned at least as well as by the hand-loading method. The miner now cleans the coal on the company's time instead of his own. We used black blasting powder for hand loading and now use permissible explosive for the pit-car loading; the advantages and disadvantages of the latter are well known. We have eight arcwall or mounted cutting machines in service,

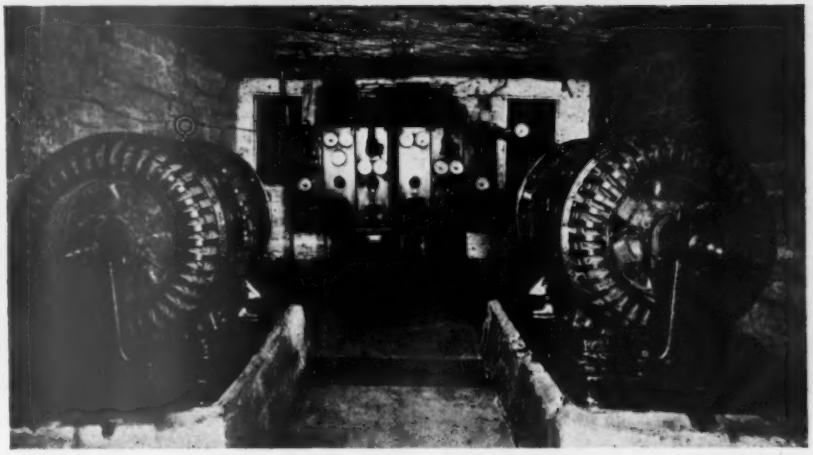
Superior Coal Co.—Form 114. DAILY TIME REPORT

Mine No._____ Date_____ 19____

Check Number	Hrs.	Rate	Distribution	Check Number	Hrs.	Rate	Distribution
				0			
				1			
				2			
				3			
				4			
				5			
				6			
				7			
				8			
				9			
				0			
				1			
				2			
				3			
				4			
				5			
				6			
				7			
				8			
				9			
TOTAL CHECKED				TOTAL CORRECT			

By _____ Mine Foreman.

Daily Time Report—8¼ in. x 5¼ in.



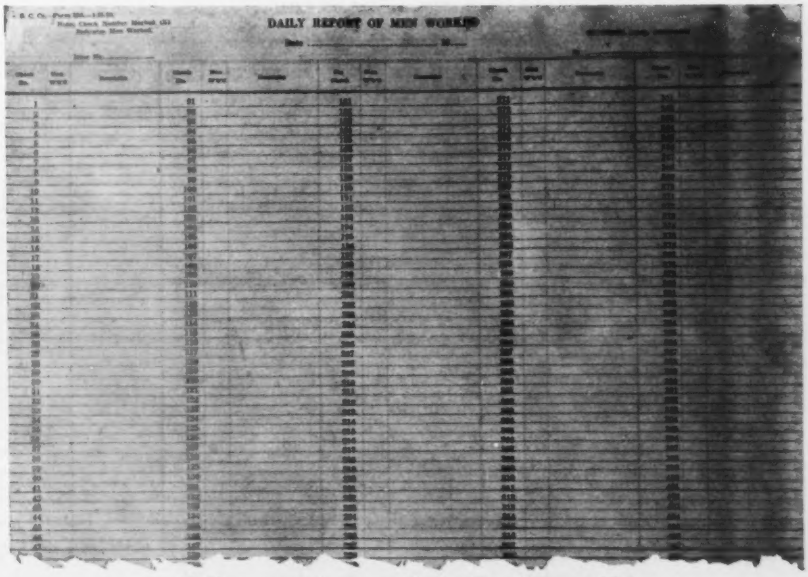
Interior of underground substation

which, besides being more efficient than the other types of cutting machines, are a distinct help in the shooting of the coal. We also had to learn the uses and abuses of electric drills.

The haulage came in for its share of thought. Where previously the cars had been loaded to the limit it was found inadvisable to try to follow that idea with the conveyor loading. Of course, this made more cars to be pulled and hoisted for the same tonnage. Then came the problem of tools, and the Storekeepers' Department was brought into the picture. It was his duty to carry an additional stock of supplies and it was necessary that he compile a new set of records that the best material for the job be purchased. He also found that because of the concentration of territory that the cost for props and caps at one mine was reduced 1.2 cents per ton, and the cost of motor ties was reduced 0.57 cent per ton.

We are pleased to know that all of the benefits of a 100 per cent conveyor operation are not reflected on the cost sheet, neither do all of the advantages accrue to the operator of the mine. Under the hand-loading method the miners of the Superior Coal Company loaded far above the average tonnage per day as compared to other mines in Illinois or elsewhere. Naturally, this meant that the loading of coal was essentially a young man's job and the older men were either forced out of the mines or given employment more suited to their age. On a basis of foot-pounds the labor required of the conveyor loader is hardly half of that used by the hand loader, and many of our miners who had given up loading are now working on conveyors.

Another source of grief in the Illinois mines was the great difference in wages between the different classes of workmen; it was not unusual for an expert machineman to make a wage three times that of an expert tracklayer. Again, some men were subject to the most rigid discipline and other classes of labor were subject to little or none. Some employes were required to work 8 hours to the minute, while the time worked by other employes was largely governed by themselves. This lack of discipline brought



Daily report of men worked—Size 14 in. x 17 in.

Mine car loaded by hand

Mine car loaded with conveyor

about through years of custom, coupled with the necessity for hurry was not helpful in preventing accidents and the money spent for injuries does not all come out of the operator's pocket.

Our miners are safer in the mechanically operated mines. Some of the risks have been removed and others have been lessened. Sprained backs by the loader are becoming rare. Broken feet and hands caused when placing chunks on the car or when chunks break and fall on their feet are forgotten incidents. Less than 10 per cent of the men who formerly handled explosives are now handling them. Men work closer together and get better supervision, and employes are more ready to use the employer's time to prevent injuries than they were their own. To offset this, of course, is the risk caused by the added machinery. It may be true that conveyors do not automatically prevent accidents, but it is true that the installation of conveyors provide the management of a mine with the opportunity to prevent accidents. Whether he takes advantage of this opportunity is another story.

It may be interesting to state that no men were laid off because of the installation of conveyors, although it was necessary for many of them to divide work. Lists were made of all of the employes and their qualifications and each man was put in the classification of work that would give him the best working time. At one of the mines there is no division of work at this time, and it will be but a short time until there is none at the other mine.

During the calendar year 1929, we produced 1,786,797 tons of coal at mines 1 and 4, all of which was loaded with pit-car loaders. We are now installing the same type of pit-car loader at mine 2.

The writer does not believe that the worries of installing pit-car loaders are much different from installing other types of mechanical loaders, but any one who has successfully established either has our sympathy and regard.

If we had all repeat it the first person to be consulted would be the electrical engineer, for the success of the operation depends on him more than on any other man.

(*Discussion follows on next page*)

A C Co.—Form 11A

SUPERIOR COAL COMPANY—DAILY OPERATING REPORT.

Mine No.———— Date ———— 19—

HOISTED HOURS	1	2	3	4	5	6	7	8	Total
Cars Hoisted Hourly									
Steam Pressure									
Delays on Top									
Delays on Bottom									

Days Worked To Date ( ) Loaded Today ———— Tonnage Produced Today ———— Tonnage Brought Forward ———— Total Tonnage To Date ————

	Loader	Pick	Total
Cause of Shut Down			

Cause of Delays On Top: ————

Cause of Delays on Bottom: ————

OPERATING STATISTICS	Unit No. 1	Unit No. 2	Unit No. 3	Unit No. 4	Unit No. 5	Unit No. 6	Unit No. 7	Unit No. 8	Unit No. 9	Unit No. 10	Unit No. 11	Unit No. 12	Total	Brought Forward	Total To Date	Daily Average
Location																
Foreman																
Tonnage Produced																
Tons Per Loader																
No of Places Cut																
No of Holes Drilled																
Powder Used																
No of Cars Pulled																
No of Cars Hoisted																
No of Conveyors																
No of Loaders																
No of Pare Men																
All Other Employes																
Total No of Employes																

INSIDE LABOR COST	Amount	Amount	Amount	Amount	Amount	Amount	Amount	Amount	Amount	Amount	Amount	Amount	Total Cost	Brought Forward	Total Cost To Date	Average Cost Per Ton
Loading Coal															Date	To Date
Pare Men																
Machine Men																
(29) Total Mining Cost																
(30) Track Work																
(31) Hauling Coal																
(32) Timbermen																
(41) Ventilation																
(42) Slate																
(23½) Repairs Conveyors																
Total																

MINE MANAGER COST	(21) Cars & Loc.	(22) T & M.	(26) Cut Mach.	(26½) Conveyor	(42) Slate	(30) Manager	(20) Track	(31) Rel. Men	(23) Haul. Coal	(41) Ventilation	Total Men	Total Cost	Brought Forward	Total Cost To Date	Average Cost Per Ton
No of Hrs Worked														Date	To Date
Labor Cost															

NIGHT FOREMAN COST	(21) Cars & Loc.	(22) Del. Pow.	(26) Cut. Mach.	(42) Slate	(42) Inc. & S.	(30) Timber	(23) Haul. Coal	(20) Props & C.	Total Men	Total Cost	Brought Forward	Total Cost To Date	Average Cost Per Ton
No of Hrs Worked												Date	To Date
Labor Cost													

TOP FOREMAN COST	(21) Cars & Loc.	(22) T & M.	(26) Cut. Mach.	(23) Rep. Bldgs.	(30) Hoist	(20) Por'ds Wt.	(22) Power P.	(23) Teaming	(20) Props & C.	(28-40) W. & Wash.	Total Men	Total Cost	Brought Forward	Total Cost To Date	Average Cost Per Ton
No of Hrs Worked														Date	To Date
Labor Cost															

Additions & Betterments Foreman	A. E. F No.	Amount	Cost To Day	Brought Forward	Total Cost To Date

TOTAL BOTTOM LABOR COST ————

GRAND TOTAL LABOR COST. ————

MATERIAL COST ————

TOTAL LABOR & MATERIAL COST ————

Compiled ———— CLERK.

Approved ———— MINE MANAGER.

Daily operating report—Size **16** *in. x* **10¾** *in.*

DISCUSSION

A 100 Percent Pit Car Loader Operation

J. S. McKeever, *general superintendent, Kanawha & Hocking Coal & Coke Company:*

I have noted a few items which appear to me to be the prime ones on this subject. That may not agree with what you think about it, but I am going to tell you what I think, anyhow.

In the first place, when you come to think about the installation of any mechanical contrivance in a mine, you have got to sell the idea. Naturally that idea must be sold to the man who furnishes the money. When you do that, you must make an estimate.

I might explain that I am solely connected with the operating end of this business. I find it expedient to be conservative in those estimates. They will be checked and double checked. That thing having been done, the matter of investment being considered, and the promise of performance made, the next item is to sell the local management at the mine where the machinery is to be installed on the idea. If you can not sell that idea to them, then you had better give them or it away, because your apparatus will not be satisfactory unless that thing is done. We have found in our experience where mine foremen expressed the idea that the apparatus would not work; it didn't work, as long as they were there.

The different systems of operation would be the next thing in my mind to be planned. We are still experimenting. We have had pit car loaders in operation less than a year. We have tried different methods. The best method we have found so far has been to put a crew of three men on each machine. Cut the coal by another crew of men, put the three men on the machine, and serve them with mine cars as rapidly as they can load them. We have found that to be the best method of operation, no matter where the machine is placed.

We have used them on pillars, we have used them in the driving entry, and we are using them in the rooms. As I say, we are still experimenting and we do not know where they will be most efficient and just exactly what method of mining, whether the old room pillar system, as we are using, will do, or whether a modified plan will do, whether a long wall plan will be better. We find those things as we go along.

The next object, to my mind, and it is the most important one, is to sell the idea to the miner himself. That, of course, as you know, is the hardest thing to do. I can quite well remember when the first cutting machine was put into the coal mine. I remember one mine in Pennsylvania where the men came out on strike and told the company they would not work with the machines. They didn't work for two or three days. That was a union district, and the union officials came there and told them to go back to work.

It is hard to show the miner how he can by the use of this machinery earn more money for the same labor or earn the same money with a lot less labor. That must be done before these machines, or any machines, can be successful. The miner must make more money with the same labor or the same money with less labor.

Frequent inspection must be made. You must have your mechanical or electrical men—most of us have the two of them combined into one—make frequent inspections. Frequent inspections save breakdowns. Breakdowns cost money.

If you will permit me a little aside, I heard one of the papers this morning that treated of the physical examination of employes. We began about two years ago to examine all of our new employes. We thought it would be a good idea to have an examination made of all of our old men, but we didn't think it advisable to say to them that they *had* to be examined. We advised our doctor that every time a man came to see him for something, he should make that as an excuse to examine him and make a record of that examination.

We have found that he has been able to detect in advance physical troubles that that man was having. If a man is sick at home, or is in the hospital, he is not an asset either to himself, his family, or to the company for which he is working. That has saved us money, aside from the compensation cost that he would be to us, if we allowed the malady or the deficiency in his physical organism to go on.

The same thing is true of these machines. Frequent inspection keeps them working. Along with that inspection, teach the operator of the machine the best way to operate it and to care for minor adjustments and minor repairs.

My idea is to get the operators of these machines in the frame of mind that we fellows had who drove the mules at one time in the mines. My mule was always a better mule than yours, and I could haul more coal than you could, at least I would say I could. That is the feeling we must get over to the operators of these machines to make them successful, not only pit car loaders but any other mechanical devices that you put into your mines.

A contented man, doing his day's work easily, earning good wages, is the best asset any company can have. By the introduction of machines that take the labor out of work you will get that result.

Mechanical Mining and Safety

(*Continued from page* 91)

inclusive (on which date the mine was closed down), we produced with conveyors 117,463 tons of coal and with hand loading 57,561 tons. With conveyor loading we suffered 26 accidents, losing 504 days. Average number of days lost per accident, 19.10. With hand loading at mine No. 7 we had 54 accidents, with a total of 2,527 days lost, or 46.43 days per accident. This, however, included one fatal accident, figured at 1,750 days, in addition to which one man injured in February was unable to report for work on March 31, 1930. Exclusive of the fatal accident, with hand loading, we experienced 53 accidents, with 777 days lost. Average number of days lost per accident, 15.7.

Taking into consideration the number of days lost, there was produced, with mechanical loading, 592.7 tons; with conveyor loading, 233 tons; and with hand loading, 74 tons per day lost.

E. J. Christy, *consulting engineer, The Wheeling Township Coal Mining Company:*

Instead of making a comparison between our old method of mining and our present (which is mechanical) in the old orthodox method, namely, accidents per ton, severity and frequency rates, etc., I believe it would be more illuminating to show the actual savings we have made in dollars and cents on our accidents since starting up on a mechanical basis.

At the time the operation was started up in March, 1928, our state insurance rate was $4 per $100 of pay roll. The six-month period rates following the above rate were $2.87, $3.37, and at present is $2.65. The last figure shows a reduction in rate of 33.8 percent, which, if figured into savings, would mean reduction per ton of .012, or a net savings of $10.123. Exceptions may be taken to these figures since the old rate was based on a higher wage scale. The higher wage scale is more than compensated for when we consider that under hand mining the average tons per day per man on pay roll was 5.5 tons, while under mechanical mining it is 7.5 tons. Therefore, if we were operating under the hand method, even with a lower wage scale, the pay roll cost per ton would be higher than it is now with mechanical loading, for in order to maintain our present daily tonnage we would need more men on the pay roll, which also would naturally increase our accidents.

A One Hundred Percent SCRAPER OPERATION

By C. R. Stahl *

TO develop for long-face work, cross entries are driven with a distance of 1,600 ft. between adjacent aircourses. At right angles to the cross entries are driven the entries on which the scraper coal is loaded. These entries and aircourses are driven on 40-ft. centers and are 20 ft. wide, thus making the chain pillar 20 ft. thick. From 2 to 3 ft. of bottom rock is shot in both entry and aircourse as long-face coal is loaded in both places. The bottom rock is gobbed next the chain pillar. The chain pillar is not recovered.

In the past all entries had been driven by hand loading, but within the past year we have developed a system of driving entries with the scrapers. The entry coal, however, not being 100 percent mechanically mined, is not discussed in this paper.

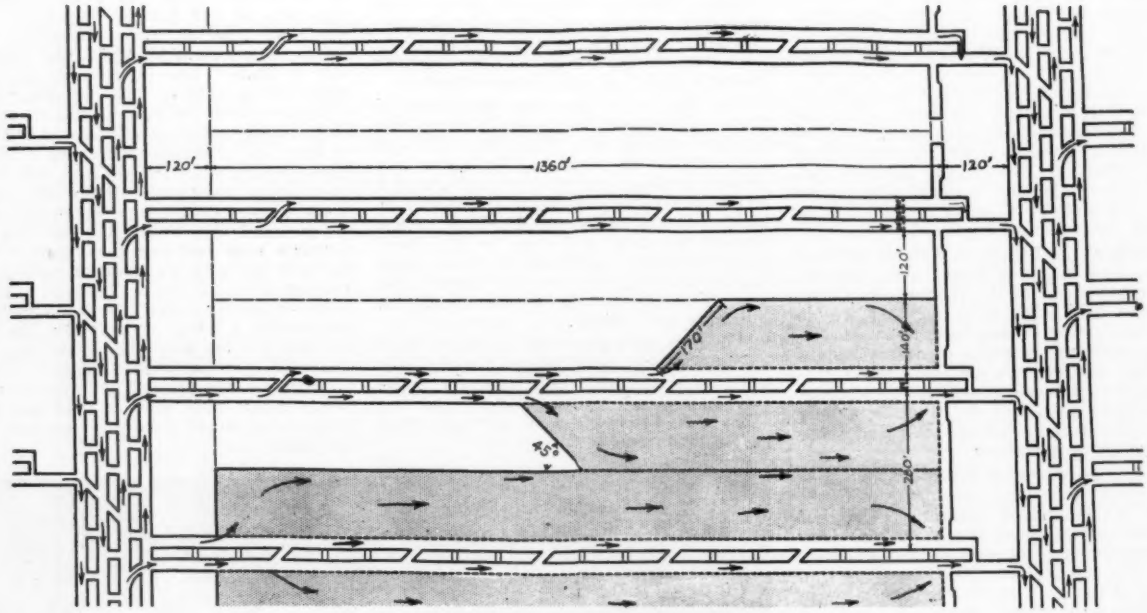
The mining system is long face with scraper loading on the faces. Two faces are worked in each panel—each entry has a track and serves as a haulway for the face on that side. One face is kept in advance of the other so that the roof breaks from the chain pillar to the solid coal, or to the fall, a distance of 140 ft. The angle face on 45 degrees is 170 ft. long. The scraper is dragged along the face, collecting the coal as it travels and discharges it over a chute into mine cars on the haulageway.

The scraper is operated by a double-drum hoist which is set some distance down the entry to obviate frequent moving. The movement of the scraper is regulated by bell signal from the face. The double-drum hoist is 35 horsepower, and the scoop carries 1,500 pounds of coal per trip. The hoist location is along the chain pillar outby from the working face, and is moved once every 10 days or so.

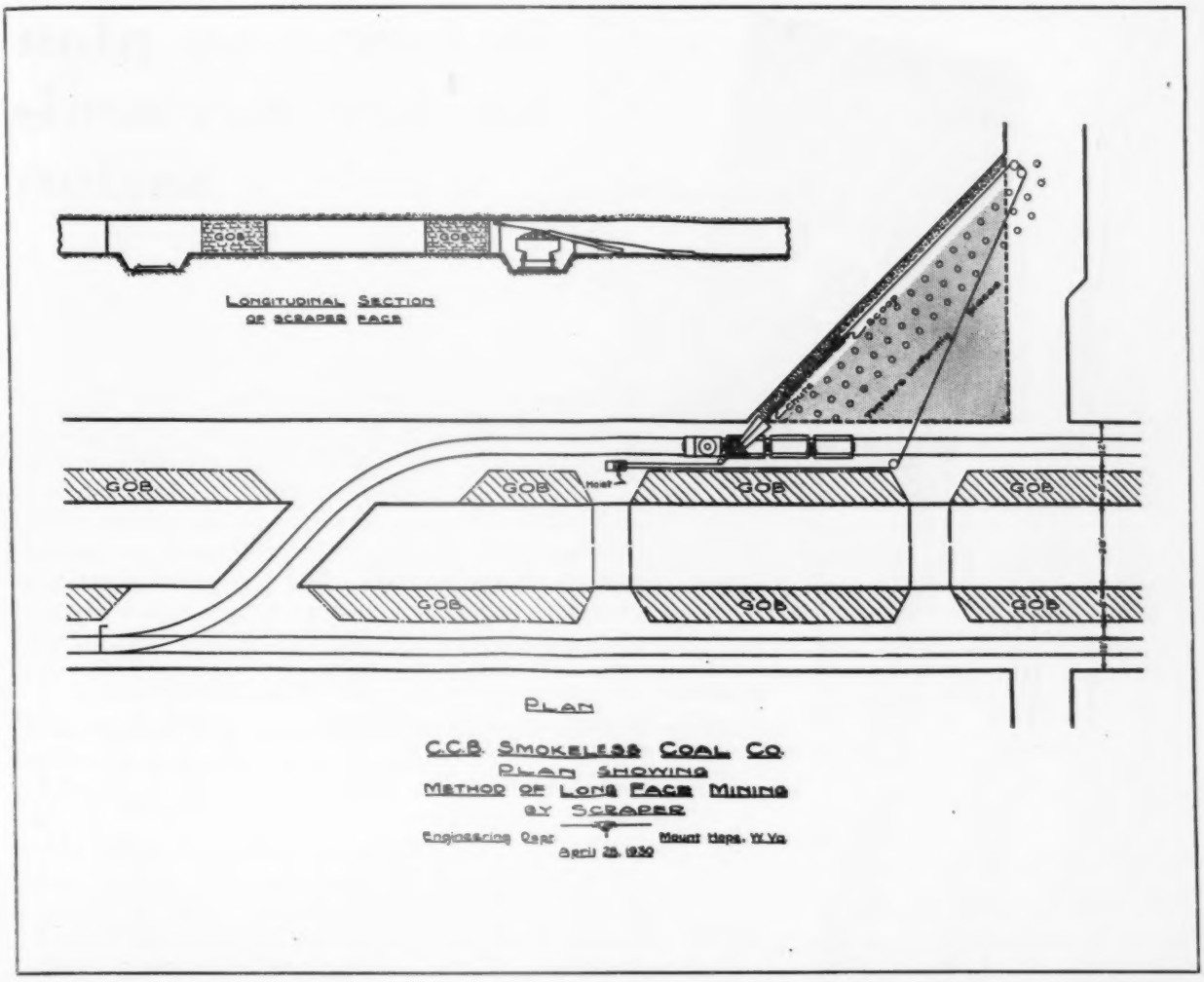
The chain pillar being left in serves as a temporary support during the mining and tends to localize the roof breaks. The intention is that the roof shall break at right angles to the entry, and, therefore, not close off the working face.

A row of timbers is set parallel to the face after each cut has been loaded out. This is done by one man who works on the day shift, and timbers both faces,

* Division Superintendent, C. C. B. Smokeless Coal Company.



C.C.B. SMOKELESS COAL CO.
PLAN SHOWING
METHOD OF LONG FACE MINING
BY SCRAPER
Engineering Dept. Mount Hope, W. Va.
Scale 1" = 100'
April 25, 1930



there being two faces working. Posts are a little heavier than used in room-and-pillar mining, and are 8 in. and upward in diameter. These posts are set 8 ft. apart, under normal conditions, closer when necessary.

The roof falls are at irregular intervals, the top being a strong sandstone. Frequently we have as much as 100 ft. between falls. Timbers are not recovered. Sometimes, with unfavorable roof conditions, a break will come along the back end of the face for 50 or 60 ft. In this case the work continues as usual, the face being lengthened rapidly on subsequent cuts until it has reached its original length.

The faces retreat at a rate of one cut per day. An 8-ft. cutter-bar is used, and because the cut is made perpendicular to the face, the rate of retreat parallel to the entry is about 12 ft. per day.

The working crew per unit consists of the following:

Machine cutter	1
Timber men	½
Face men	2
Hoist operator	1
Signal man	1
Motor crew	2
Foreman	½
Total	8

Of these, the machine and timbermen work in the daytime; the balance of the crew working at night. Cars are shifted at the loading face by the motor crew, the brakeman acting as car trimmer. The foregoing schedule includes delivery of the coal to the shaft bottom.

The coal bed has local pitches frequently as high as 12 percent, and usually has good sandstone top. The coal is clean and the bottom is hard and is free from jumps or bumps. The thickness of the coal varies from 30 to 48 in. The only limitation we have found in working thin coal by this method is the height necessary to operate the cutting machine. The sequence of operation is as follows:

The timberman precedes the cutting machine and sets the timber. The cutting crew then cuts the coal, one crew of two men with one machine cutting both faces. This leaves a night operating crew, besides the boss, of six men per unit consisting of two face men, one hoist operator, one signal man, and the motor crew of two men.

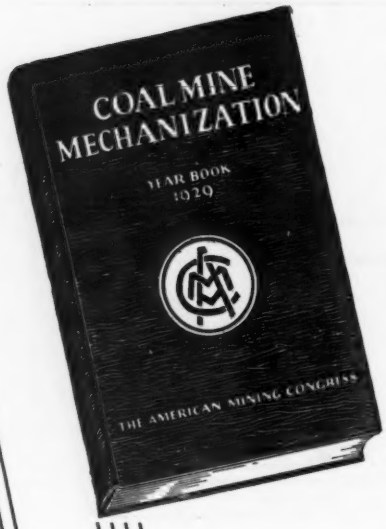
The night crew working as a unit first moves the chute down the entry to its new loading position and blocks it into place. The under-cut is next bug-dusted and the machine cut is loaded out. The drilling is then done by means of an electric power drill, and the holes are shot one at a time.

Loading is first done from the back end of the cut, the scraper being pushed into the loose coal by the face men as it gathers up its load. The loading out of the back end of the cut first enables the face men to change the jack settings from time to time so that the scraper will be self-loading.

The work of taking out the coal is usually the easiest and smallest part of the job. It is done almost entirely without hand labor and does not consume one-half of the 8-hour shift.

The machine crew cuts by contract. All of the other men are paid by the day, and all receive the same wage excepting the foreman. The system is the task system, the men being expected to clean up once during a shift. Therefore, the working crew for the complete job consisting of 16 men including the boss, are expected to cut, shoot, load, timber and haul the coal from two areas, each 150 ft. long and 8 ft. deep, to the shaft bottom about half a mile away. The quantity of coal produced per shift varies, of course, with the thickness of the coal bed.

During the year 1929, these two machines loaded out a total of 76,067 tons of coal of an average thickness of 40 in., with a recovery of 88 percent. Including all men employed in connection with the long-face work, the coal delivered to the shaft bottom was at the rate for the year of 12.3 tons per man-day.



Before you plan further mechanization

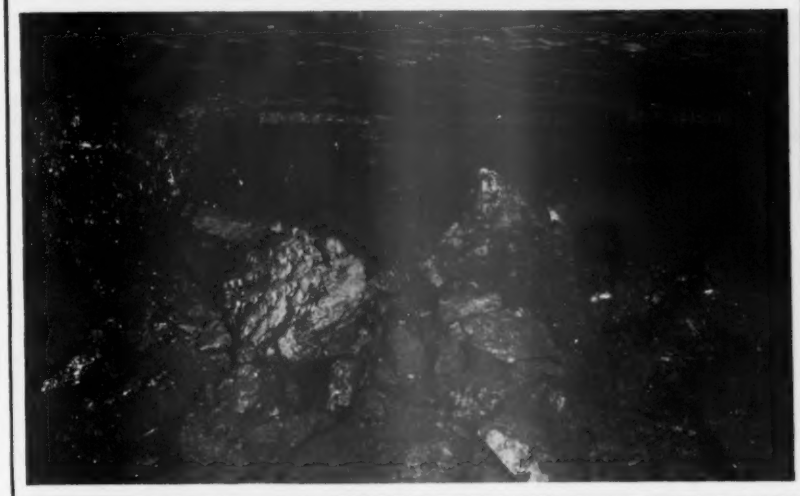
Before you plan further mechanization of your property study this book carefully. It is a most important aid to efficiency and economy in the application of machine methods to coal mining. The most successful means devised for meeting all conditions are presented to you in a careful and unbiased manner. It helps you to get the "breaks" in mechanization. Other men's experiments are yours to build on. Every man in the field will want it for its helpful suggestions.

It pictures in detail the progress of this important turn of coal mining. It discusses and describes mechanization, its developments, its economical phases, its progress in the several fields in the United States and foreign countries; it carries the actual reports of the mechanization survey conducted by The American Mining Congress; it carries a brief illustrated description, impartially presented, of the loading and conveying equipment offered by the American manufacturers. There are discussions by authorities on safety, power, ventilation, and room and pillar recovery.

Reports of the actual survey of The American Mining Congress include an outline of the latest developments in mechanical loading; descriptions of actual operations covering mechanical loading, conveyor mining and scraper mining; a study of the effect of mechanical loading on the several phases of mining. These reports are comprehensive, graphically illustrated by charts and diagrams and will be invaluable to everyone concerned with the important subject of mechanization of coal mining.

The Yearbook on Coal Mine Mechanization is attractive, readable and serviceable. It is bound in flexible fabrikoid cover and printed on high quality coated paper. $3.00 per copy. $2.50 each in lots of 5 or more. $5.00 each in combination with a subscription to The Mining Congress Journal.

THE AMERICAN MINING CONGRESS
841 MUNSEY BUILDING WASHINGTON, D. C.



A SIMPLIFIED LIST OF MODERN PERMISSIBLES

Only 8 years ago (1922) Hercules listed 37 permissibles to meet the individual and general blasting demands of the coal mining industry. Among these were brands which could be ranked with the best available at that time for any particular condition.

Today, as a result of a development program started in 1923, we offer a list of 9 modern permissibles which cover an even greater range more completely and effectively than did the 37 powders replaced.

This remarkable simplification means that the coal mining industry need choose from only 9 permissibles, each representing a distinct advance over the 37 older types in efficiency or economy, or both.

This is an outstanding example of Hercules' untiring research and exhaustive study of field conditions to produce greater explosives values and to make the selection of explosives easier. You can select the proper permissible for your coal from the list at the right. Check the coupon-list for further information.

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(INCORPORATED)

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BUFFALO
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Wilmington Delaware
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WILKES-BARRE
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The Permissible For Your Coal Is In This List

☐**HERCOAL-F:** The new type lump producer. A very high cartridge count permissible (about 500)* with black powder action.

☐**HERCOAL-D:** This Hercoal lies between F and C in count (about 450),* and like them is a black powder action, lump producer.

☐**HERCOAL-C:** Another black powder action, lump producing permissible. Lower count (about 400),* and stronger per cartridge than Hercoal-F.

● ● ●

☐**RED H F-L. F.:** Slow and strong with a cartridge count of about 356.* A lump producer.

☐**RED H D-L. F.:** Slow and strong. Cartridge count around 316*. Another lump producer.

☐**RED H C-L. F.:** Slow and strong. About 276* count and a lump producer.

☐**RED H B-L. F.:** A fast, dense, strong permissible of about 280* count with a smashing action.

● ● ●

☐**COLLIER C-L. F.:** Fast and strong but with higher count (about 320)* than Red H B-L. F.

☐**HERCOGEL:** Dense and strong. Suitable for wet work. Count about 190.*

*NOTE: Cartridge counts refer to the number of 1¼" by 8" cartridges in 100 lbs. of explosives

● ● ●

HERCULES POWDER COMPANY
934 King Street, Wilmington, Delaware

Gentlemen: Please send me pamphlets describing the Permissible explosives checked.

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Company.....
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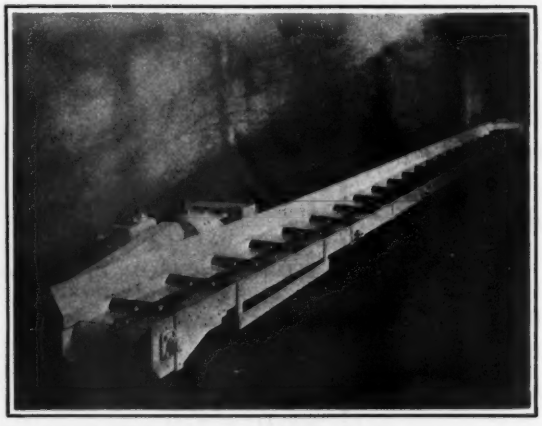
B-8

V16 I7 JUL SUP 30 XUM

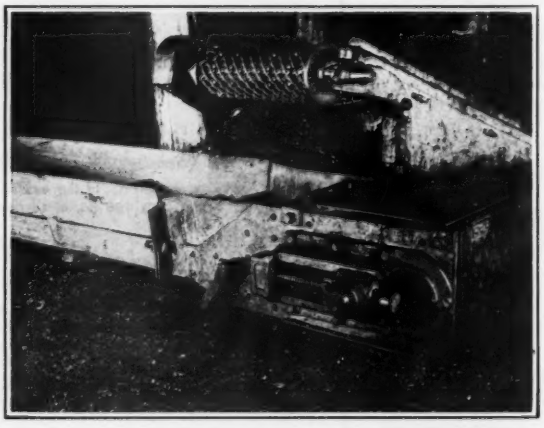
Mat Face Conveyor in Operation

in Underground Conveyors



Type FB 150 Ft. Modified Long Wall Face Conveyor

Mat Face Conveyor Discharging into end of Type W Main Line Conveyor

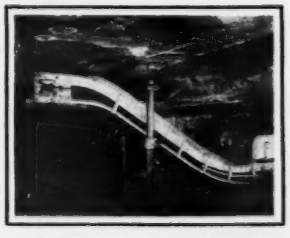


Gellatly conveyors are successfully operating in seams as low as 20 inches under all systems of mining—room and pillar, double room and modified long wall. They are built to stand hard usage and can be designed to meet the specifications of your own mine. Our organization takes pride in keeping them at peak efficiency.

GELLATLY and COMPANY
Incorporated
Oliver Building, Pittsburgh

GELLATLY

Discharge end of Type W main line conveyor showing Gellatly Set-up Jacks



HAZARD

Mining Rope

Keeps Tonnage on the move at low cost

HAZARD Wire Mining Rope has built its reputation for unequalled service on the foundation of the highest quality steels, followed by the finest craftsmanship.

And every operation in manufacture—from the drawing of the wire to the final closing of the rope—is based on specialized study and intimate knowledge of the service requirements of each rope.

The result is a rope that does its work efficiently and economically—and keeps tonnage always on the move at low cost.

Let Hazard Engineers look over your wire rope requirements, and recommend the type of rope most suitable for each operation. Ask to have one call. It may lead to a welcome reduction in your wire rope costs.

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WILKES-BARRE PENNSYLVANIA

New York Pittsburgh Chicago Denver Los Angeles San Francisco Birmingham

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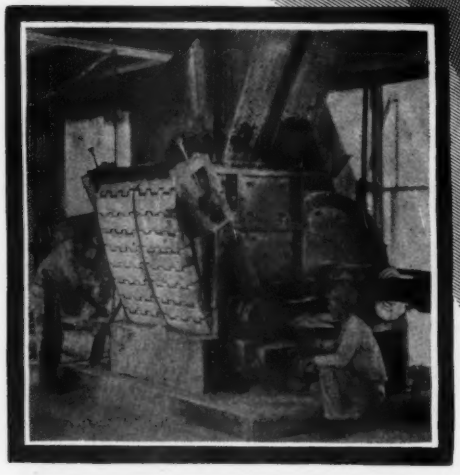
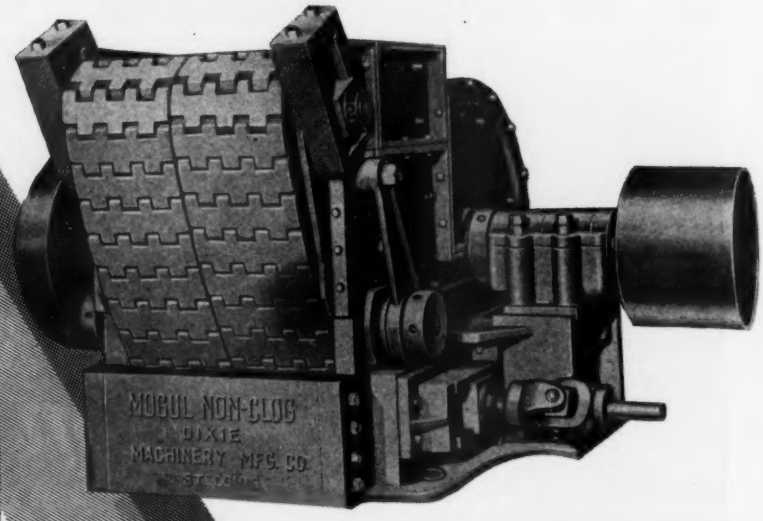
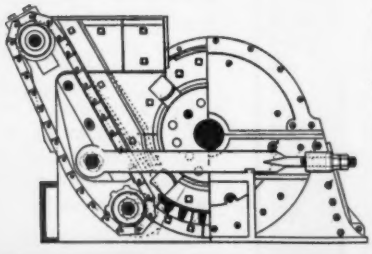
DIXIE

Some Users:
Russian Government.
Evergreen Mining Co.
Wisconsin Steel Mines
Manganiferous Iron Co.
Alpha Portland Cement Co.
International Cement Corporation.
Missouri Portland Cement Co.





Sectional view of Dixie Mogul Non-Clog Hammermill, showing moving breaker plate and the simplicity and sturdiness of its design.



WITH material that would continually clog the feed of ordinary crushers, the Dixie Non-Clog Hammermill operates smoothly and uninterruptedly. This ease of operation, due to the continually moving breaker plate, illustrated above, makes obvious reduction in horsepower and cost per ton. Maintenance costs are at a minimum. Any adjustments can be made by inexperienced operators. All parts are easily accessible. The simple principle of the moving breaker plate gives long life and reliability, and handles difficult feed easily with uninterrupted service. Our catalog describes these and our standard hammermills in detail. Write for it.

We would like to send you our illustrated catalog that describes details of construction and operation. Write for it.

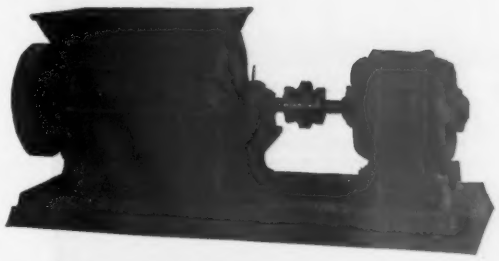
DIXIE MACHINERY MANUFACTURING CO.
SAINT LOUIS, MISSOURI

NON-CLOG HAMMERMILL

750,000 Tons Coal Crushed

(to stoker size)

Without One Cent for Repairs



Direct driven Standard "S" Type Coal Crusher mounted on bed plate, front view. Built in sizes ranging from 25 to 500 T. P. H.

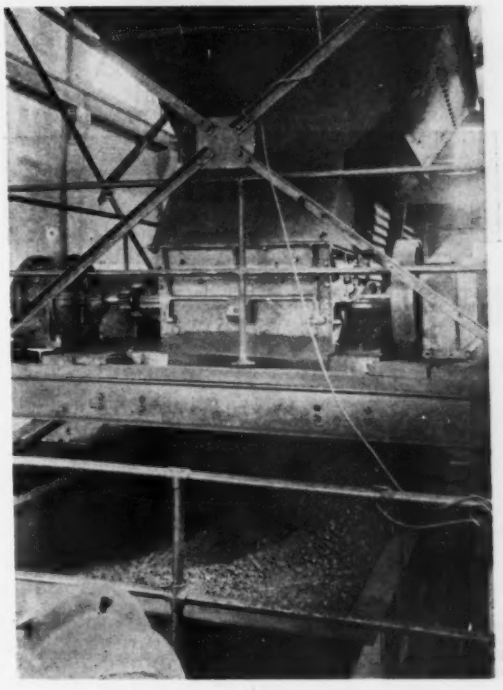
PROVING the high operating efficiency of American Rolling Ring Crushers, we have received numerous reports of over a HALF MILLION TONS of coal being crushed without One Cent for repairs. WHY?

American Pulverizer Company are the Originators and Patentees of the Rolling Ring Crusher Principle and have devoted their entire efforts for the past twenty years to the refinements in design and manufacture.

A new modern plant, equipped to make nothing but crushers, has added materially to increased efficiency in the machines themselves and this is handed down to buyers at no increased costs.

Let us bid on your next requirements and we will gladly furnish engineering service, if desired, in working up design.

These patented manganese steel Shredder rings are reversible and are only found in American Rolling Ring Crushers. They split the coal instead of smashing it insuring uniformity with minimum fines.



Low type crusher for installation in tipples where headroom is limited. Crusher height but 26".

ORIGINATORS OF THE ROLLING RING CRUSHER PRINCIPLE

AMERICAN PULVERIZER CO

1249 MACKLIND AVE · ST·LOUIS·MISSOURI

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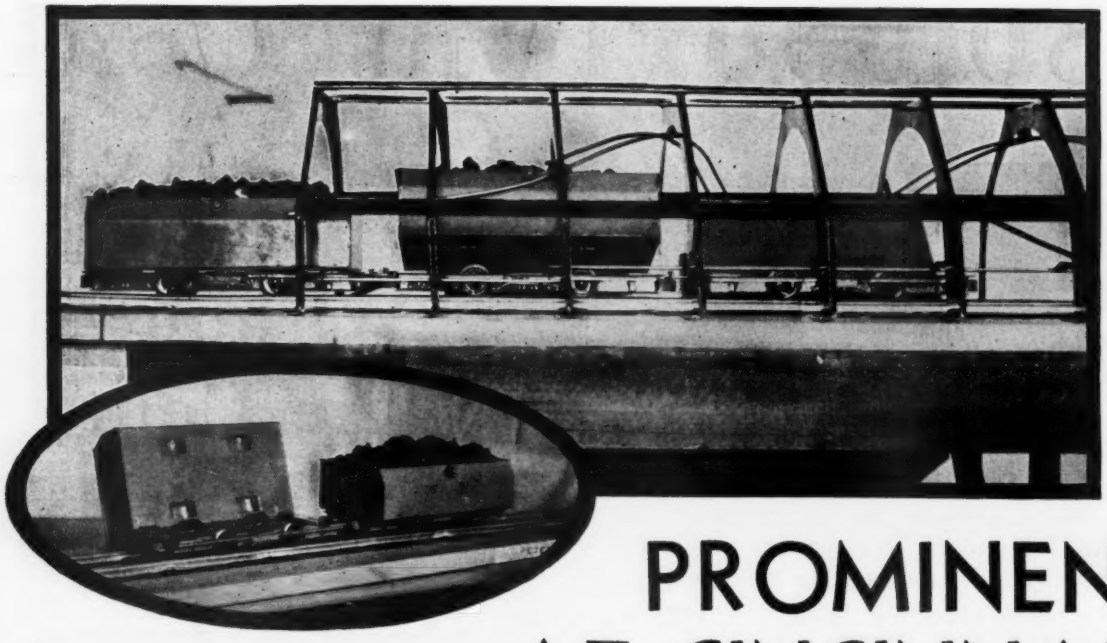

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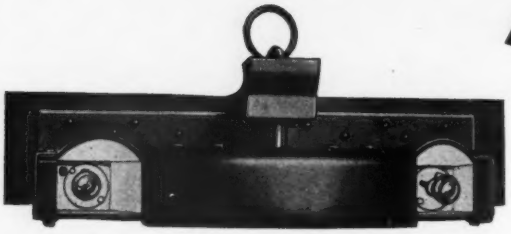
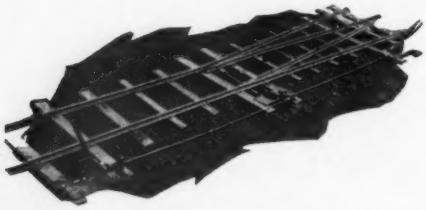


WATT MOTOR BUMPER is built to withstand punishment. Lights located so as not to blind workmen. Eliminates expensive headlights. Comes to you assembled. Fits any locomotive.



WATT AUTOMATIC SWITCH is simple and positive. Operated by a lever and weight. Nothing to get out of order. View shows switch set as a Flying Switch so motorman may go through and return by another route.

Watt equipment shown here came in for more than its share of the spotlight at the Cincinnati Convention. Watt engineering and manufacturing ability always are abreast of the demands of coal and metal mining haulage.

W-A-G
COAL DUMPING SYSTEM

The W. A. G. (Watt-Allen & Garcia) Coal Dumping System, illustrated above, gives every indication of being the fastest, simplest and most economical dumping method ever offered the coal mining industry.

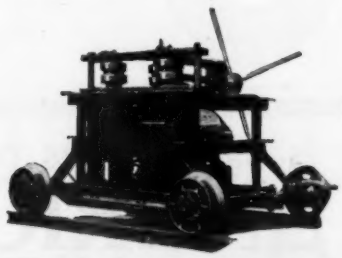
With this system a whole trip is pulled through the dump without stopping. Each car body goes up in a wave-like action, dumps and waves gently down into position. Dumping speed is greatly increased. Provision is made for by-passing cars of rock through the dump without dumping.

We would be pleased to talk over the possibilities of a W. A. G. System for your mine.

The WATT CAR & WHEEL COMPANY
BARNESVILLE, OHIO

Send for a Blueprint of BLUE BOY

WATT BLUE BOY is the new mine car with the Watt Style Z-Bar design that has revolutionized construction and makes possible 10% to 15% greater carrying capacity without change in body dimensions.



WATT RAIL BENDING and straightening machine straightens rails or bends them to any desired radius. For reverse curve flip rail over, no need to turn end for end. Machine made stationary or portable.

UNIVERSALS

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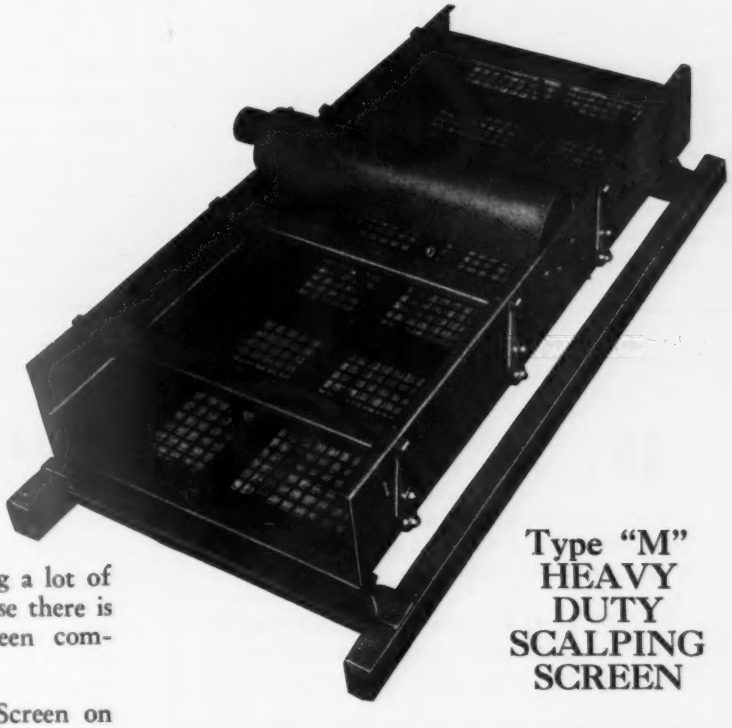
A Screen Need Not Be Complicated and Costly

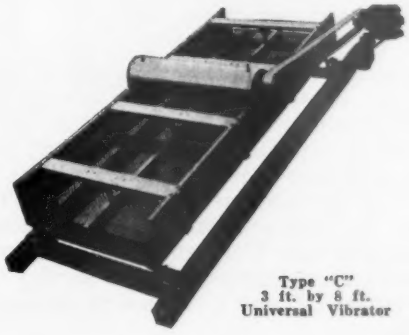


Type "M" HEAVY DUTY SCALPING SCREEN

There is no justification for spending a lot of money for a Vibrating Screen because there is no justification for making a Screen complicated.

The UNIVERSAL is the simplest Screen on the market. It is free from the furbelows and furbishments which add much to the cost and nothing to actual performance.

The utter simplicity of the UNIVERSAL gives you many advantages. First, the UNIVERSAL costs less, due to simple design and large production on standard size units. Second, the UNIVERSAL costs less to operate and maintain, again due to its simplicity, and also because of the oversize strength of parts. The only attention it asks is occasional lubrication at two accessible points.



Type "C"
3 ft. by 8 ft.
Universal Vibrator

And the efficiency of the UNIVERSAL'S screening is outstanding. It gives you a clean, more uniform, finer separation which quickly shows up in the improved quality of your Product.

Before you buy any Screen—investigate the UNIVERSAL. The ADVANCED TYPE "C" SCREENS and the TYPE "M" SCALPING SCREENS described in the New — 32-page catalog—No. 90 will interest you.

Write for Your Copy Today

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ONE important source of wealth and commercial supremacy of our country *must be* low cost fuel. Inexpensive fuel, resulting in cheapness of power, allows competition in world markets against the low wage labor of other countries.

Coal is the present greatest source of power. The wider application of power itself is doing much to reduce coal production costs —costs which must be much further reduced if the industry is to maintain its present important place.

To this end the American Mining Congress is conducting a most practical and constructive service. Functioning through the National Committee on Mechanized Mining and under the constant and direct supervision of its Mechanization Division, headed by Mr. G. B. Southward, it is conducting a survey of progress in mechanization in every coal field in the country. This work is carried on by more than a hundred of the outstanding operating men located strategically throughout the whole territory. Reports cover operating methods, types of equipment, local conditions and mining systems and make available a summary of all phases of mining—cutting and shearing, drilling and blasting, mechanical loaders, conveyors, scrapers, transportation, ventilation, power, roof action, coal cleaning, management and safety. This constructive work is furthering the best interest of your cause. It merits the support of every man concerned in the production of coal.

Your Mine and World Trade

Through this work your membership in the American Mining Congress helps tangibly to insure your present and future prosperity. It is a practical and far sighted undertaking, helping to put your industry on a more stable and profitable basis.

Your membership in this organization also brings you other benefits which are made available through such services as its Tax Division; its Standardization Division; its Bureau of Mining Mechanization; its Weekly Bulletin of pertinent news; its regional Industrial Development work; The Mining Congress Journal. The Annual Coal Conventions and Expositions are another service of the American Mining Congress to the coal industry.

We have prepared an attractive booklet describing this nation-wide survey of coal mine mechanization which we will be glad to send to any one interested.

THE AMERICAN MINING CONGRESS
841 Munsey Building, Washington, D. C.

I will be pleased to receive a copy of your booklet, the National Committee on Mechanized Mining.

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(Position and Company) .....

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.....

SPOKESMAN OF THE MINING INDUSTRY

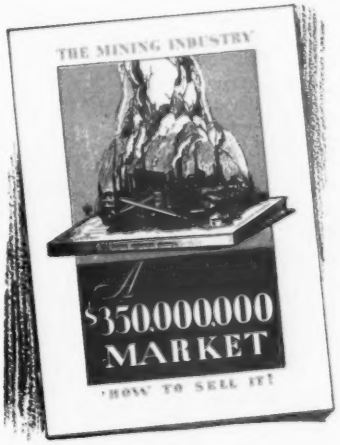
IN every industry and in every business organization there is one man or group of men recognized as *the source of buying authority.* In these all-important and hard-to-reach men is vested the power to say "yes" or "no" to every plan or proposal involving the purchase of materials, equipment and supplies.

In this, the mining industry is no exception. Here, too, there is a source of buying authority which must know you and your product—must be conscious of your advertising. Has *the source of buying authority been considered* in your 1931 advertising plans?

Sell at "the Source of Buying Authority"

Eight thousand nine hundred key men and responsible executives read The Mining Congress Journal. Practically all of them have authority to buy, or exert influence over purchases in their organizations. Fifty-eight per cent of Mining Congress Journal subscribers are operating companies and executives. Twenty-one per cent are mining, electrical, mechanical, and consulting engineers. Nineteen per cent are superintendents and foremen.

Its twelve 1931 issues will give you complete coverage of this rich market. Its industry and exposition numbers will place your product before every important purchasing executive in the industry. Your message presented here will reach this $350,000,000 market where you would like to reach it—*at the source of buying authority.*



The Mining Industry—A $350,000,000 Market—How to Sell It is the title of a booklet prepared for you by The Mining Congress Journal. It contains a wealth of fact information that our readers tell us have helped them formulate successful sales plans and policies for 1930. We believe you will find it helpful in outlining and determining your sales program for 1931. Send for it.

The MINING CONGRESS JOURNAL

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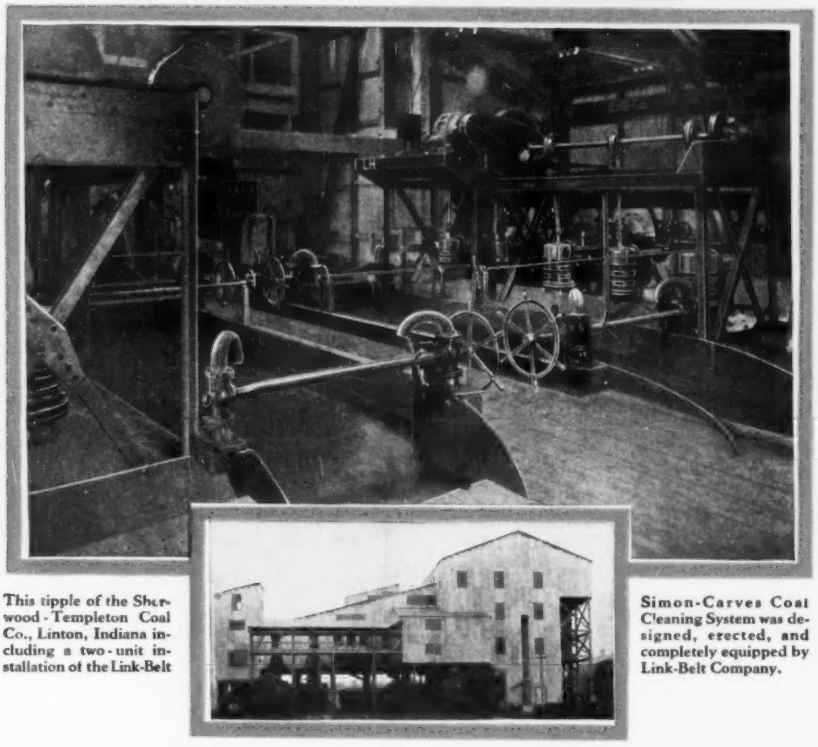
First one successful plant then a repeat



This tipple of the Sherwood-Templeton Coal Co., Linton, Indiana including a two-unit installation of the Link-Belt

Simon-Carves Coal Cleaning System was designed, erected, and completely equipped by Link-Belt Company.

INTRODUCED to the American Coal Mining Industry hardly more than two years ago, the Link-Belt Simon-Carves Coal Cleaning System has already reached the "repeat order" stage.

The Central Indiana Coal Co. at Linton, had an opportunity without equal for testing the efficiency of their Link-Belt Simon-Carves installation.

With impurities reaching 30 to 35%, theirs was a most formidable cleaning problem. But the Simon-Carves equipment handled it so successfully the same ownership ordered the Link-Belt Simon-Carves System and complete Link-Belt equipped tipple for their Sherwood-Templeton Coal Co. strip mine shown above.

In addition to this 2-unit Link-Belt Simon-Carves installation with a capacity of 100 tons per hour each, handling all the output 4" and under, the tipple designing, erecting and equipping was a complete Link-Belt job.

Compactness, simplicity, low capital outlay and operating cost, positive attainment of results—the mining industry is justified in the greater interest they are constantly expressing in the Link-Belt Simon-Carves System.

LINK-BELT COMPANY 3885

Leading Manufacturers of Materials Handling and Power Transmission Machinery and Chains

CHICAGO 300 W. Pershing Road

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